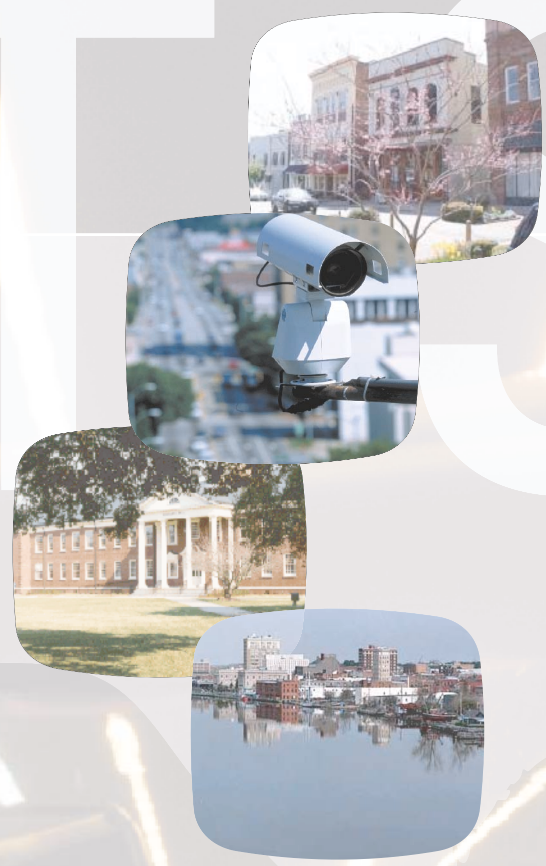
Wilmington Regional Report



North Carolina Statewide
Intelligent Transportation System
Strategic Deployment Plan

SMART link
Getting You There Safely

Prepared by:

Kimley-Horn
and Associates, Inc.

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List of Abbreviations/Acronyms[1]

APTS	*Advanced Public Transportation Systems*. FTA program to focus R&D and funding efforts on ITS technologies composed of five main areas: vehicle operations and communication, high occupancy vehicles, customer interface, rural transportation, and market segment development.
ARTS	*Advanced Rural Transportation Systems.*
ATIS	*Advanced Traveler Information Systems*. Vehicle features that assist the driver with planning, perception, analysis, and decision-making.
ATMS	*Advanced Traffic Management Systems*. An array of institutional, human, hardware, and software components designed to monitor, control, and manage traffic on streets and highways.
AVL	*Automatic Vehicle Location*. The installation of devices on a fleet of vehicles (e.g. buses, trucks, or taxis) that enable the fleet manager to determine the location of specific, AVL-equipped vehicles in the road network.
CARAT	*Congestion Avoidance and Reduction for Automobiles and Trucks*. ATIS/ATMS system in Charlotte, NC involving an advanced transportation management center (TMC) and a subscription-based advanced traveler information system (ATIS) that will provide incident location and response as well as consumer information to its users. This is the original acronym/name for the system and has been replaced with the name “Metrolina Regional Transportation Management System”.
CBD	*Central Business District*.
CCTV	*Closed Circuit Television*.
Clearinghouse	A clearinghouse stores real-time data for traveler information. The system will include data from system loops, intersections, a detector station, posted incident reports, IMAP incident reports, and real-time bus schedule information. All information whether it is stored locally or remotely, will be accessible from a central location.
CVO	*Commercial Vehicle Operations*. The application of ITS technology to commercial vehicles.

[1] A number of the definitions regarding communications devices and protocols are from, “Newton’s Telecom Dictionary,” 16th Edition, Harry Newton, Telecom Books, February 2000.

CVISN	*Commercial Vehicle Information Systems and Networks.* Refers to the ITS information system elements that support CVO.
DMS	*Dynamic Message Signs*.
DMV	*Department of Motor Vehicles*.
DSL	*Digital Subscriber Line*. A generic term for a family of digital lines that provide high-speed data transfer rates across standard telephone lines. Typical bit rates on a DSL connection range from 128kbs to 8Mbs.
FHWA	*Federal Highway Administration*.
HAR	*Highway Advisory Radio*. The transmission of localized traffic advisory messages using 520 AM and 1610 AM frequencies.
HOV	*High Occupancy Vehicle*. Any vehicle containing more than one person.
IMAP	*Incident Management Assistance Patrol.* A service run by the NCDOT to identify freeway incidents and assist emergency personnel.
Incident	Any accident, stalled vehicle, or other delay-causing problem on a street or freeway.
ISDN	*Integrated Services Digital Network*. Leased-line data network over telephone lines. A typical ISDN line connects at 128kbs but is more costly in both the end equipment and monthly cost.
ISP	*Information Service Provider.*
ISTEA	*Intermodal Surface Transportation Efficiency Act*, passed by Congress and approved by the President in December of 1991, becoming Public Law 102-240.
Kbs	*Kilobytes per second*.
Kiosk	An interactive information center for traffic or travel data located in shopping malls, parking decks, hotels, airports, businesses, transit terminals, etc. It always has interactive computer capability and sometimes has communications linkage to real-time traffic data.
Market packages	The FHWA has identified 56 market packages that describe projects in general terms and identifies the information that must be shared between the various components.
Mbs/Mbps	*Megabits per second*.
MDT	*Mobile Dispatch Technology*.
MPO	*Metropolitan Planning Organization*.

MRTMC	*Metrolina Regional Transportation Management Center*
Multimodal	The use or ability to use multiple modes of transportation; i.e., automobiles and buses.
Multiplexers	Electronic equipment that allows two or more signals to pass over one communications circuit.
NIA	*National ITS Architecture.* The NIA is a framework that describes what a system does and how it does it. The architecture identifies the functions to be performed by the system, allocates these functions to subsystems, and defines the flows of information and the interfaces between the subsystems and components.
PART	*Piedmont Authority on Regional Transportation.* Regional Transportation between Winston-Salem, Greensboro, and the regional hub at Greensboro Regional Airport.
RSVP	*Ride Sharing Vehicle Program*.
RWIS	*Roadway Weather Information System.*
Smart Card Technology	A regional electronic payment system that permits the same method of payment for all transit systems in the region. In addition to permitting travelers to use multiple bus systems without a complicated payment system, Smart Cards enable the various transit and planning agencies to better track ridership, transfers, and other information that can be used to plan for future transit enhancements.
T-1	A digital transmission link with a total signaling speed of 1.544 Mbps.
TAC	*Transportation Advisory Committee*.
TCC	*Traffic Control Center*. Sometimes used interchangeably with Traffic Operations Center (TOC). Strictly defined, TCCs primarily control traffic while TOCs are headquarters for enforcement, operations, and maintenance personnel. TCCs and TOCs often are combined functionally.
TCC	*Technical Coordinating Committee*.
TEA-21	*Transportation Equity Act for the 21st Century*
TMC	*Transportation Management Center*.
TMS	*Transportation Management System.*

Traffic Signal Systems	A system of interconnected traffic signals (signal controllers) whose major objective is to support continuous movement and minimized delay along an arterial or a network of arterials.
TRTMC	*Triangle Regional Transportation Management Center*
TTA	*Triangle Transit Authority*.
User Packages	A list of 63 technology groups that define ITS elements and projects. Where a Market Package defines a general goal of ITS, User Packages define the technologies and deployments that compromise the Market Package.
VRAS	*Voice Remote Access System*.
VMT	*Vehicle Miles Traveled*
WIM	Weigh-In-Motion.

Executive Summary

The North Carolina Department of Transportation (NCDOT) is developing a Statewide Intelligent Transportation Systems (ITS) Strategic Deployment plan. The purpose of this plan is to develop a structured implementation of ITS projects by addressing the immediate and long-term transportation needs of the state.

Developing any statewide plan requires input from many sources, not just from a statewide board or agency. The statewide plan, therefore, is the result of several regional plans, developed through an aggressive stakeholder outreach program that invited the input from well over 1,500 people of different backgrounds. This document represents responses to the statewide plan from the stakeholders in the Wilmington Region.

The process that was used throughout the development of the regional and statewide ITS deployment plans follows the requirements and direction of the National ITS Architecture (NIA), a framework that describes ITS components by their functionality and defines how these components are to work together as a system. The architecture identifies the functions to be performed by the system, allocates these functions to subsystems, and defines the flows of information and the interfaces between the systems, subsystems, and individual elements.

The Wilmington region includes parts of New Hanover, Brunswick, and Columbus Counties. Major cities in this region are Wilmington, Carolina Beach, Wrightsville Beach, Castle Hayne, Shallotte, Long Beach, and Whiteville. Although relatively new, there are several ITS deployments that are either fully functional, in construction, or in the planning stages throughout the Wilmington Region.

From the stakeholder input process, the ITS Strategic Deployment Plan process identified 30 transportation needs. These needs were ranked and the most pressing issues were identified, which in turn, permitted the use of the NIA to develop a regional ITS deployment plan and architecture that addressed these needs.

From this process, it was determined that hurricane evacuation, en-route driver information, pre-trip travel information, and route guidance were the most urgent issues. Short- and long-term project plans were then determined from the needs. The key component of the Wilmington Region ITS Deployment plan is to develop a central database of traveler information to be disseminated to motorists throughout the region.

The concept of the Wilmington Regional architecture is that City of Wilmington and NCDOT control the traffic operations equipment through the region, and, therefore, has easy access to most of the generated traffic information. External inputs, such as from the Incident Management Assistance Patrol (IMAP) program and the NCDOT statewide program office needs to be accessed, but not generated or stored locally. The concept of the architecture is that the City of Wilmington and NCDOT share information both regionally and, to some extent, statewide to provide information that can be easily accessed from one concise front end.

The regional communication is limited because of the deployments, both existing and planned, and the geography of the region. The system will encompass the existing communications between Wilmington and the existing ITS elements, with new deployments providing or improving communication, as necessary.

Introduction

ITS are applications of advanced traffic operations and communications technologies used to improve safety, relieve congestion, and provide better information to travelers. The NCDOT has determined that a blueprint is needed to guide future deployment of ITS throughout the state. This guided deployment of ITS will result in an integrated, cost-effective plan that will increase motorist safety and security, preserve infrastructure and services, ensure transportation system efficiency, provide information, and increase economic development opportunities throughout North Carolina.

The statewide ITS Strategic Deployment plan will consist of a compilation of statewide needs and the needs gathered in nine Regional ITS Strategic Deployment Plans. This Wilmington Regional ITS Deployment plan represents one of those nine regional reports. To guide the future deployment of ITS technology in the state, NCDOT is developing a statewide ITS Strategic Deployment plan. This planning process has developed a structured implementation of ITS projects by addressing the immediate and long-term transportation needs in the state. The Department is committed to improving the safety and efficiency of North Carolina's transportation systems, including transit, rail, aviation, bicycle, and pedestrian, as well as highways.

Developing a statewide plan of any sort requires input from a broad base of stakeholders across the board, not just from a statewide board or agency. The statewide plan, therefore, will be the result of three rural and six urban regional plans. Each of these independent but coordinated plans has been developed through an aggressive stakeholder outreach program that invited input from approximately 1,500 people from different backgrounds who have important influence over or opinion on North Carolina's transportation system. This deployment plan takes into account the issues of previously developed area-wide plans as well as multi-modal plans from local agencies.

The Wilmington Regional ITS Plan is intended to be a living document that represents a consensus of ideas and concerns from municipalities and other entities in this region, the Division and other NCDOT representatives, and from a diverse group of stakeholders in the North Carolina transportation system.

Introduction to ITS

Increasing the capacity of the transportation network has traditionally been the responsibility of transportation planners, highway designers, and road builders. When a roadway neared capacity, the most frequent response by the NCDOT and other public agencies was to add additional lane miles. Today, as development increases, it is becoming increasingly difficult to add additional lanes without expensive right-of-way acquisitions. ITS has evolved over the last decade to describe a federal emphasis area for transportation systems. ITS also denotes a body of knowledge and discipline area among transportation systems, vehicle systems, and communication systems engineers. The federal program was first authorized by the 1991 Intermodal Surface Transportation Act (ISTEA) and continued by the 1998 Transportation Equity Act for the 21st Century (TEA-21).

The program is supported by all modal administrations within the United States Department of Transportation (USDOT), and by a broad-based professional association called ITS America, which acts as an official advisor on the ITS program to the USDOT and the various administrations of that department and other entities. The National Program Plan for ITS identified the following goals for the national program:

1. Widespread implementation of ITS to enhance the capacity, efficiency, and safety of the federal-aid highway system; to serve as an alternative to additional capacity of the federal-aid highway system; and to enhance development of intermodal connectivity.
2. Enhance, through the more efficient use of the federal-aid highway system, the efforts of several states to attain air quality goals established pursuant to the Clean Air Act.
3. Enhance the safe and efficient operation of the nation's highway system, particularly system aspects that will increase safety. Identify system aspects that may reduce safety.
4. Develop and promote ITS and the ITS industry in the United States.
5. Reduce social, economic, and environmental costs associated with traffic congestion.
6. Enhance U.S. industrial and economic competitiveness and productivity.
7. Develop a technology base for intelligent vehicle-highway systems and establish the capability to perform demonstration experiments, using existing national laboratory capabilities, where appropriate.
8. Facilitate the transfer of transportation technology from national laboratories to the private sector.

ITS, in short, is the use of advanced traffic operations technologies and communication technologies that help increase throughput on existing facilities, improve safety, and provide better and more accurate traveler information to the public.

Additional throughput is occurring in many ways. Advanced traffic surveillance and signal control systems, for instance, have resulted in travel time improvements ranging from 8 to 25%. Incident management programs can reduce delay associated with congestion caused by incidents by as much as 45% and freight mobility systems have shown productivity gains of more than 25% per truck per day[2].

The following two examples illustrate the beginnings of ITS programs in North Carolina. At the rest areas associated with some of the welcome centers on interstate highways entering the state, traveler information kiosks promote tourist attractions, highway safety messages, highway construction zones, highway services, hotels, restaurants, etc.

These interactive traveler information kiosks provide printed directions to destinations and have the capability of downloading html files that could convey weather information, real-time traffic conditions, incidents, etc. They are a basic, in-place building block for an Advanced Traveler Information Systems (ATIS) in this region. The same type of facility exists at several welcome centers in North Carolina and Tennessee. This private-sector partnership with the state is an excellent example of how ITS is already deployed, and is extremely popular with the tourism industry in the state.

The second example of an in-place component that relates to the ITS program is a freeway assistance service operated by the NCDOT along various portions of I-40 and I-85 in North Carolina. These service patrols (part of the statewide IMAP service that exists in various districts of the NCDOT) provide emergency services such as gasoline, emergency starts, communications, etc. for stranded motorists. They also help to direct traffic around incidents. NCDOT trucks are equipped with communications equipment that could make them effective “vehicle probes” that provide traffic condition information to an information clearinghouse or to one or more of the regional Transportation Management Centers (TMC) in the Triangle, the Triad, or Metrolina.

2 Benefits data is taken from various sources, including: Meyer, M., “A Toolbox for Alleviating Traffic Congestion and Enhancing Mobility,” Institute of Transportation Engineers, 1997; Intelligent Transportation Systems: Real World Benefits, prepared for FHWA Intelligent Transportation Systems Joint Program Office, Apogee/Hagler Bailly, January 1998; and, „Review of ITS Benefits: Emerging Successes„, Prepared for Federal Highway Administration, MITRETEK Systems, September 1996.

Introduction to the ITS Strategic Planning Process

The process that is used throughout the development of the regional and statewide ITS deployment plans follows the requirements and direction of the NIA. The NIA is a framework that describes what ITS elements and systems do and how the different elements and control centers function together. The architecture identifies the functions to be performed by the system, allocates these functions to subsystems, and defines the flows of information and the interfaces between the subsystems and components.

This section describes the process used to develop the deployment plan in the Wilmington Region. A more detailed description of the process, and the elements that make up the process used in the plan development, is provided in the Appendix.

ITS Planning Process

The general ITS planning process is shown in **Figure 1**. This methodology is described in detail in “Integrating Intelligent Transportation Systems within the Transportation Planning Process: An Interim Handbook” (FHWA, January 1998) and in the “Implementation Strategies” volume of the National Architecture. This process follows a direct path towards the development of a deployment plan.

The Regional and Statewide ITS Deployment Plans were developed through a multi-step process that meets the goals and objectives of the NIA. This process invites many stakeholders from multiple agencies to provide input into the planning process. In turn, this input is reduced into general and specific projects that form the overall regional and statewide plans.

It is the intent of the NIA that these regional and statewide plans consist of more than individual projects and technologies. The NIA was developed in response to the deployment of systems that were not compatible with one another by many state and local agencies. In addition, as these systems were being planned, designed, and deployed, neither future expansion nor interagency coordination were considered.

The NIA, therefore, is being used to foster communications between agencies with the goal of developing regional and statewide plans that facilitate interagency communication and coordination, as well as long-range visions that accommodate the future integrated growth of ITS in the Wilmington Region.

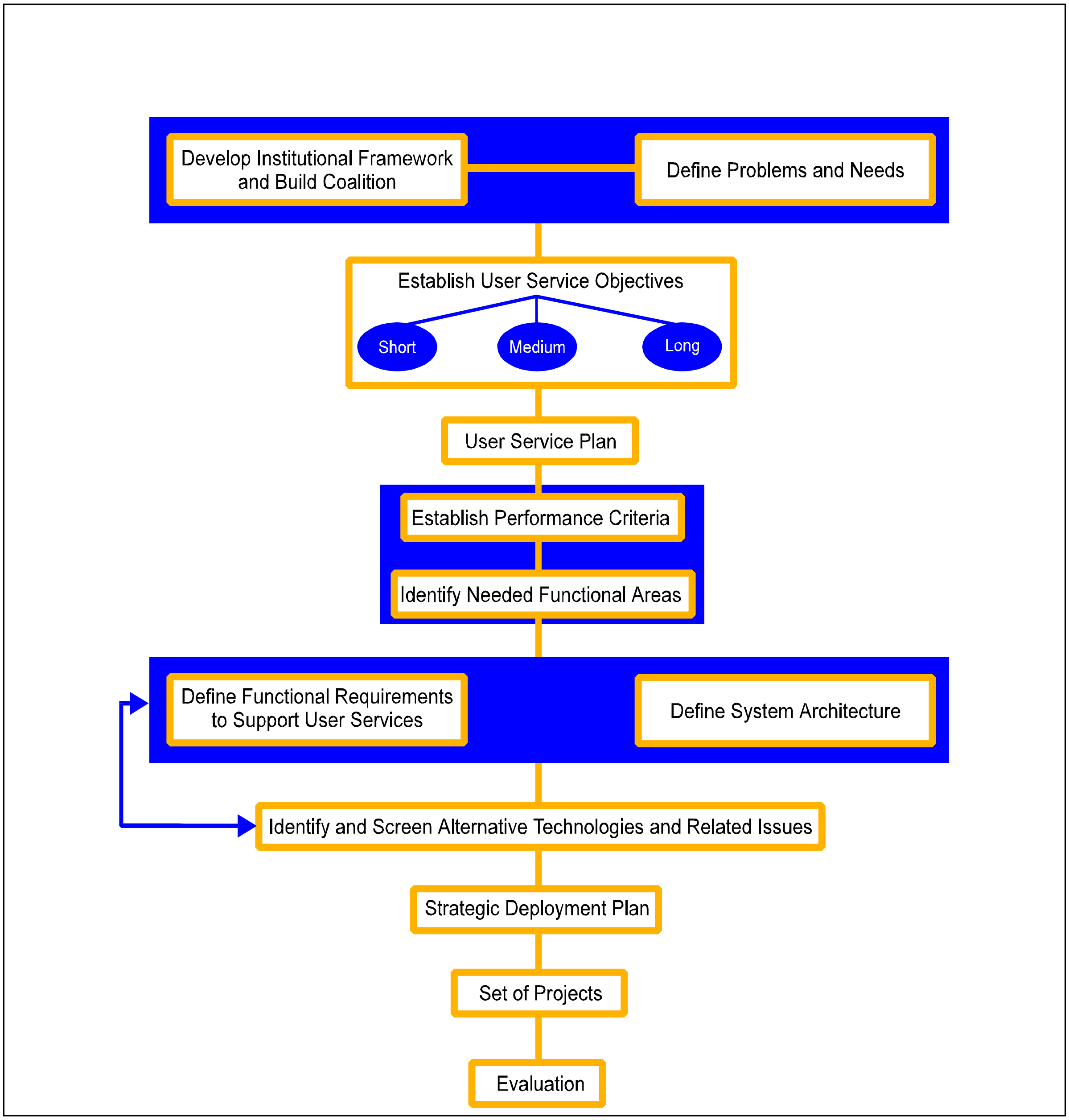

Figure 1. ITS Planning Process

Background

Project Background

Statewide

The population of North Carolina is growing. As the population grows, so, too, does the demand on the transportation system. This demand is seen throughout the state every day during the peak periods as commute times to and from work continue to increase. Recreational areas are experiencing similar congestion. The projected growth in vehicle miles traveled is shown in **Figure 2**.

The Federal Highway Administration (FHWA) has identified ITS as one of the key responses to congestion mitigation and incident response. ITS is typically more cost-effective than traditional methods of congestion mitigation, such as the addition of new lanes. It also provides tangible side benefits, such as constant data collection for use in planning and operational models.

The NCDOT has identified the need to continue expanding ITS throughout the state. Although there are pockets of deployments (such as traffic signal systems and freeway management systems), these deployments have not been coordinated and do not address all the statewide needs.

The purpose of this document is to demonstrate the need to improve the transportation system, identify ITS solutions, and provide a framework for continued deployment throughout the region and state. This document will be used as part of an overall statewide plan.

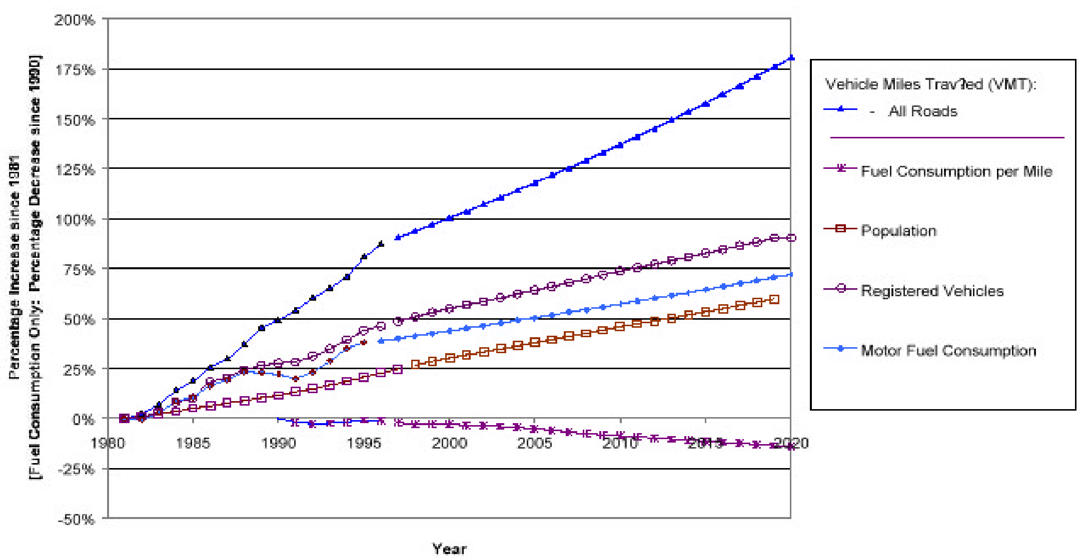

Figure 2. Projection of Key Transportation Indicators for North Carolina

NCDOT Regional Plans

The North Carolina ITS Strategic Deployment Plan comprises nine regional plans, as shown in **Figure 3** (the I-95 Region is included in the Statewide Report in the interstate system). These regions are grouped according to the ITS needs within each region. For instance, the needs in the Wilmington region focus on hurricane evacuation and traveler information, while needs in the Interstate region focus on Commercial Vehicle Operations (CVO) and a combination of out-of-state travelers, local commuter travel, and truck routes.

Each of the regions is composed of multiple stakeholders and jurisdictions. These stakeholders include cities, counties, several field divisions within NCDOT, and metropolitan planning organizations (MPOs) for the 17 urban regions in the state. Other interested organizations in urban regions include the police, fire departments, county emergency management agencies, and urban transit agencies.

Through this process, nine regional plans will be developed (the Interstate Region is included as part of the Statewide Plan). All of these plans will be combined to develop a Statewide ITS Deployment Plan that will guide each of the agencies involved as well as NCDOT in the deployment of ITS in the coming years.

Project Goals and Objectives

The Wilmington Regional ITS Deployment Strategy must be compatible not only with the regional and local goals set forth by municipalities and counties in the region but also with statewide transportation goals and objectives and the national ITS goals.

Goals of the National ITS Program

The National ITS program was initially created through the ISTEA of 1991, when Congress recognized the critical need to address the aging transportation network. ITS was identified as one of the methods of improving the network.

Since then, the FHWA has been actively pursuing ITS as a key means to improving the safety and efficiency of the transportation system. The National ITS program also has been instrumental in developing the NIA. The NIA is a response to the increased deployment of ITS without clearly defined interoperability between either systems or subsystems.

The program was extended by the ITS Act of 1998, which was a part of TEA-21. This guidance has been effective in the ongoing development and integration of ITS elements.

TEA-21 contained four provisions concerning ITS, which provides funding for the six fiscal years covered by the Act:

- ITS Deployment – small incentive grants to states and local governments to encourage ITS integration and CVO infrastructure deployment

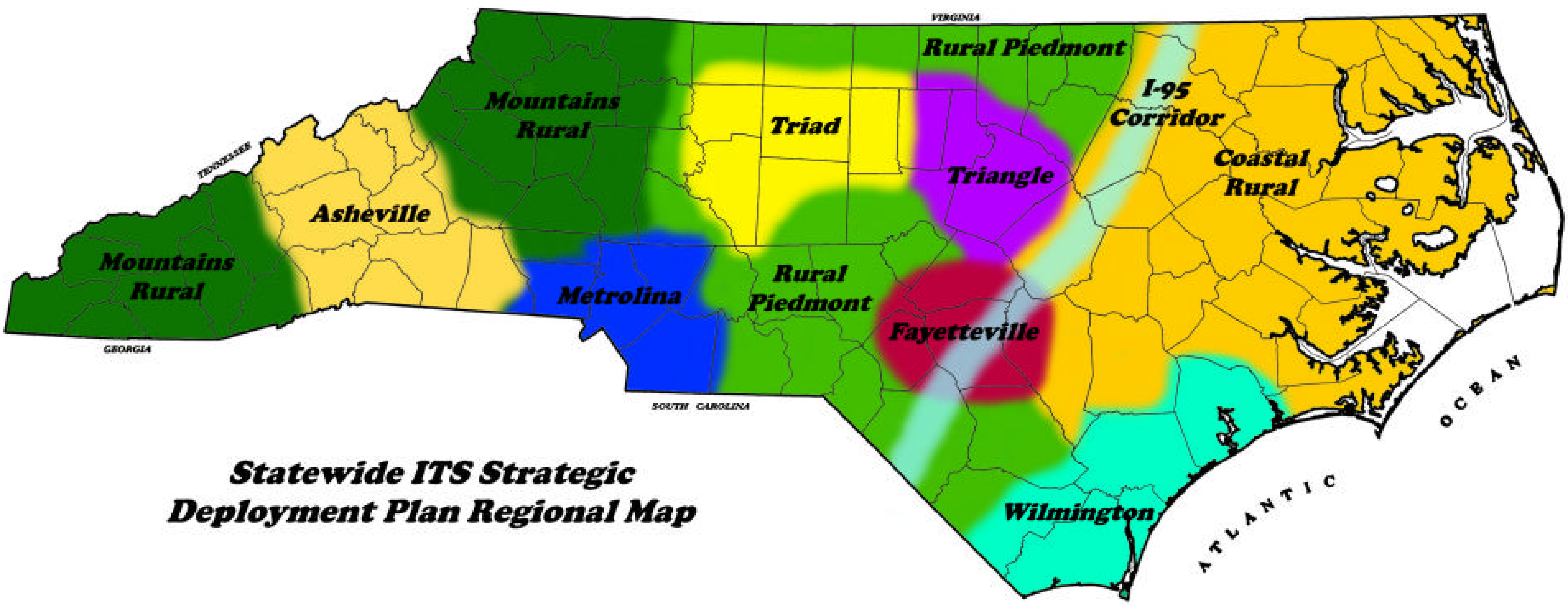

Figure 3. North Carolina ITS Strategic Deployment Plan Regions

- ITS Integration – acceleration of the integration and interoperability of ITS
- CVO Infrastructure Deployment – advancing technological capability and promoting ITS in the trucking industry
- ITS Research and Development – specifically includes funding for ITS services, among other program areas

TEA-21 lists several requirements for project funding, including:

- Contribute to national deployment goals and objectives
- Demonstrate strong commitment among stakeholders
- Maximize private sector involvement
- Demonstrate conformity to NIA and approved ITS standards and protocols [3]
- Be included in statewide or metro area transportation plans
- Ensure continued long-term operations and maintenance
- Demonstrate that personnel have necessary technical skills

Statewide ITS Goals

The overarching goal of NCDOT's ITS program is to support the Department's mission to "provide and support an integrated transportation system and related services that enhance the State's well-being."

Adding specific goals for the statewide ITS program to this mission statement, the following guiding principles that support this overall mission have been identified:

- Increase motorist safety and security
- Preserve infrastructure and services
- Ensure transportation system efficiency
- Increase economic development opportunities
- Incorporate the ideas and concerns of a broad cross-section of stakeholders in the State's transportation system
- Provide both static and dynamic transportation information, including road conditions, closures, and incident status updates
- Develop a mechanism to facilitate the sharing of information between NCDOT and other public and private agencies

[3] Note that at the time of passage of TEA-21, and at present in early 2001, the NTCIP Protocols and other ITS Standards are not all in place and established standards

In addition to these seven goals that have guided the preparation of each of the nine regional ITS Strategic Plans in the State, there is an element of incorporating ITS technologies into the overall toolbox of solutions to transportation problems. The eight goals of the Department, and the objectives that ITS helps to fulfill to meet those goals, are as follows:

- Goal 1: Provide a safe and well-maintained transportation system that offers modal choices for the movement of all people and goods.

  ITS Objective: Use ITS technologies to provide information among modes of routes, schedules, incidents, fares, vehicle tracking, and other traveler and shipper information.

- Goal 2: Provide quality customer service.

  ITS Objective: Use advanced technologies available in ITS solutions to provide "user friendly" interface between users and transportation systems and services.

- Goal 3: Develop efficient processes to provide quality transportation services.

  ITS Objective: Investigate ITS technologies and applications in appropriate projects to provide innovative and flexible solutions and incorporate those technologies where cost-benefit ratios are greater than other solutions.

- Goal 4: Demonstrate responsible stewardship of fiscal resources.

  ITS Objective: Compare ITS solutions to new capacity solutions in order to obtain the most cost-effective use of available funding.

- Goal 5: Demonstrate responsible stewardship of other resources.

  ITS Objective: Assess the environmental, energy consumption, aesthetic, and other impacts of ITS technology deployment as compared to other transportation solutions.

- Goal 6: Support the development of sustainable, vibrant communities.

  ITS Objective: Incorporate the entire ITS stakeholder base into local community efforts to support sustainable community initiatives.

- Goal 7: Maintain a quality workforce.

  ITS Objective: Use the technological skills of communications and electronics engineers to upgrade the level of technical expertise in the Department and upgrade other disciplines with cross-training in ITS technology applications.

- Goal 8: Make decisions in a manner that builds trust and mutual respect.

  ITS Objective: Develop strong, effective partnerships within the various units of the Department.

Regional ITS Goals

Two types of regional ITS goals are identified in this document: short-term and long-term.

Short-term

Short-term goals focus on improving safety and security for the traveling public in all modes of surface transportation, and increasing the quantity and quality of relevant, timely travel and traffic information to the public. Short-term goals also concentrate on building up the “human capital” resources with improved training of personnel in technical disciplines and the development of better, cost-effective ways of establishing partnerships among public agencies and between the public and private sectors to deploy ITS projects in the State. Specific short-term principles to apply as goals include:

- Increasing motorist safety and security
- Preserving infrastructure and services
- Ensuring transportation system efficiency
- Incorporating all stakeholders’ input in the planning process

Long-term

Long-term goals involve many larger projects that actually start in the short-term. These larger scope projects require a significant investment in infrastructure, planning, and coordination. A new, regional TMC, a network of advanced weather information stations, or a statewide weigh-in-motion (WIM) and truck safety system will be considered projects that fit under long-term ITS goals.

Long-term goals include all the principles applied in the short-term, plus:

- Increase opportunities for economic development

National ITS Architecture

All projects that will use federal ITS funds require the development of a regional and/or statewide ITS architecture that meets the needs and criteria set forth by the NIA. As such, the regional and statewide deployment plans require that an ITS architecture be developed. The process of developing an architecture is briefly discussed earlier in this document, in the ITS Planning Process section. A detailed description of the NIA process, goals and objectives is included in the Appendix.

Stakeholder Input Process

Figure 1 shows the multiple steps that are involved in the stakeholder input process. The first step is to establish a stakeholder coalition to develop the vision and define the goals and objectives of the plan, as well as to identify any problems. The stakeholder input process involved multiple meetings and forums with key persons and agencies. Further information on the meetings and attendees is provided in the Appendix.

Despite differences among the regions with respect to how many meetings were held, in general, the meetings in each region occurred in the following order:

Regional Kick-Off/Consensus-Building Meeting. The first task in each region was to hold a regional kick-off/consensus-building meeting. These meetings typically included NCDOT representatives from the region, city and local transportation planners and engineers, and other interested key individuals. The intent of these meeting was to briefly introduce the project and overall statewide goals, customize the deployment planning process for each region, and identify the key public and private stakeholders within the region.

Planning Sessions. Multiple presentations occurred after the project kick-off meeting and prior to the summit meeting in each region. These presentations typically included briefings of the Technical Coordinating Committee (TCC) and Transportation Advisory Committee (TAC) in each region, and the presentation of ITS information to other key transportation groups and officials in the region. The purpose of these presentations and briefings was to promote ITS goals, provide a brief overview of the benefits of ITS, and inform people about the upcoming summit in the region.

Regional Summit. One to four regional summits were held in each of the nine regions. Stakeholders in the regions were invited to these half-day events that featured a presentation of the project background, information regarding the benefits of ITS, and an opportunity for the stakeholders to share and document their key issues.

User Services and Market Packages

The goal of the stakeholder process is to develop a strategic plan of projects that can be implemented that also meet the transportation needs expressed by the stakeholders. Through the development of the NIA, the FHWA has identified 31 user services for urban areas, and 63 market packages that describe projects, and also identifying the information that must be shared between the various components. The process of identifying user services is shown in **Figure 4.**

The overall system architecture can be developed by selecting the appropriate user services and market packages. Grouping these packages together results in the overall system architecture, and shows the data that needs to be passed between elements and agencies. User packages are general categories of projects, such as traveler information.

There are seven critical program areas within ITS. Those seven programs are

Traveler Safety and Security - Technologies use a in-vehicle sensors and information systems to alert drivers to hazardous conditions and dangers. This program features wide-area information dissemination of site-specific advisories and warnings.

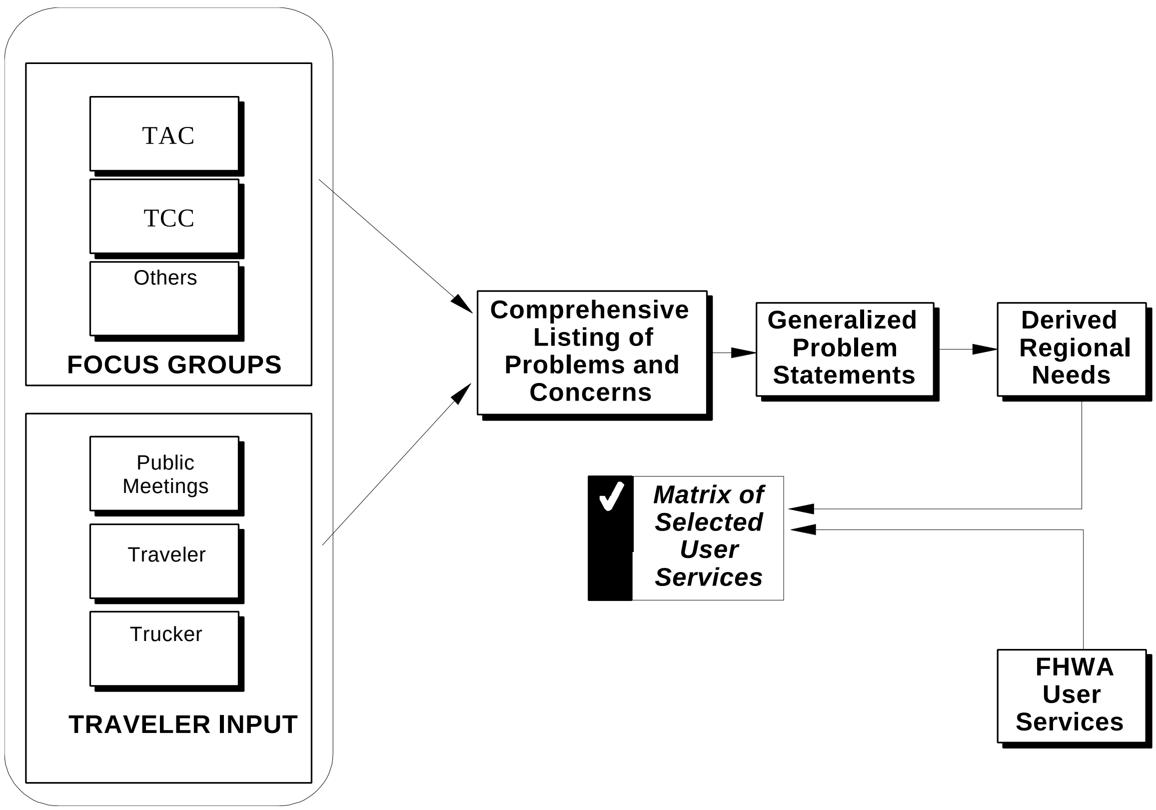

Figure 4. Identification of Needs and User Services

Tourism and Travel Information Services - Use in-vehicle navigation and roadside communication systems to provide information to travelers who are unfamiliar with the local areas. These services can be provided at specific locations, en-route, or prior to departure.

Public Traveler/Mobility Services - Improves the efficiency of transit services and their accessibility to residents. These services include better scheduling, improved dispatching, Smart Card readers and payment, and computerized ride-sharing systems.

Emergency Services - Use satellites and advanced communications systems to automatically notify the nearest police, fire, or rescue squad in case of collision or other emergency.

Fleet Operations and Management - Improves the efficiency of fleets of vehicles that operate in urban areas, such as utility readers, package delivery services, mail carriers, law enforcement, etc.

CVO - Satellites, computers, and communications systems manage the movement and logistics of commercial vehicles, and locate and track these vehicles during emergencies.

Infrastructure Operations and Maintenance - Improve the ability of highway workers to maintain and operate urban streets more efficiently. These services include severe weather information and immediate detection and alerting the public to dangers such as the presence of work zone crews.

The NIA lists potential ITS market packages to go with these critical program areas. There currently are 63 market packages in the NIA. **Table 1** lists specific market packages that are applicable to most urban regions and may be applicable in the Wilmington Region.

The following example illustrates the benefit of this categorization of market packages. The Regional ITS Summit in the Wilmington Region identified the issue of providing traveler information by using kiosks. Various types of two-way communications devices were discussed. These transportation information needs were translated into consolidated information that can be provided to the traveling public with two-way capability. Affected ITS critical program areas would include Tourism and Traveler Information as the major component. Within the Tourism and Traveler Information program area, for example, the following market packages were determined to be applicable:

- Broadcast traveler information
- Interactive traveler information
- Yellow pages and reservations
- Autonomous route guidance
- In-vehicle signing

Traffic information dissemination is another market package that is listed in the NIA as belonging in the infrastructure operations and maintenance area, and this market package also is applicable.

By identifying these five as the primary market packages to meet the needs of urban area travelers, the specific data and communication issues can be identified at an early step. The way that subsystems, technology packages, and market packages fit together in a regional ATIS architecture is shown in **Figure 5**.

The interactive traveler information market package exemplifies the market packages that are applicable to urban regional ITS architectures. This market package provides tailored information in response to traveler requests. Users can request and obtain current information on traffic conditions, traveler services, and parking. A range of two-way, wide-area wireless, and wireline communications systems may be used to support the required digital communications between traveler and the information service provider. A variety of interactive devices may be used by the traveler to access information prior to a trip or en-route including plain old telephone (POT) service; traveler information kiosks in welcome centers, truck stops, etc.; Personal Digital Assistant (PDA); home computers; and a variety of in-vehicle devices.

The successful deployment of this market package relies on the availability of real-time transportation data from the Transportation Management System (TMS) or Transportation Regional Management System (TRMS). This market package also requires an entity (or entities) to process and disseminate the information - the information service provider (ISP). The ISP interfaces with the remote traveler support subsystem and personal information access subsystem to receive individual travelers' requests and respond with information. **Figure 6** shows the Interactive Traveler Information market package. Note that the information flows to the vehicle are displayed with dotted lines. This interface will probably not be available until the mid- or long-term timeframe (depending upon how quickly services become available nationally).

Table 1. Probable ITS Market Packages Based on Typical Needs in Urban Areas

Critical Program Areas	**Specific ITS Market Packages** (Taken from the *ITS National Program Plan and National Architecture*, as amended)
Traveler Safety and Security	Traveler Security Intersection Safety Warning Intersection Collision Avoidance
Tourism and Travel Information	Broadcast Traveler Information Interactive Traveler Information Yellow Pages and Reservations Autonomous Route Guidance In-vehicle signing
Public Traveler/Mobility Services	Multimodal Traveler Information Demand Response Transit Operations Transit Passenger and Fare Management Transit Security Transit Maintenance
CVO	CVO Fleet Administration /Coordination Freight Administration Fleet Administration Electronic Clearance HAZMAT Management
Emergency Services	Emergency Response Emergency Routing MayDay Support
Infrastructure Operations and Maintenance	Incident Management Traffic Information Dissemination Probe Surveillance Traffic Forecast and Demand Management Advanced Railroad Grade Crossing Road Weather Information System
Other	ITS Planning

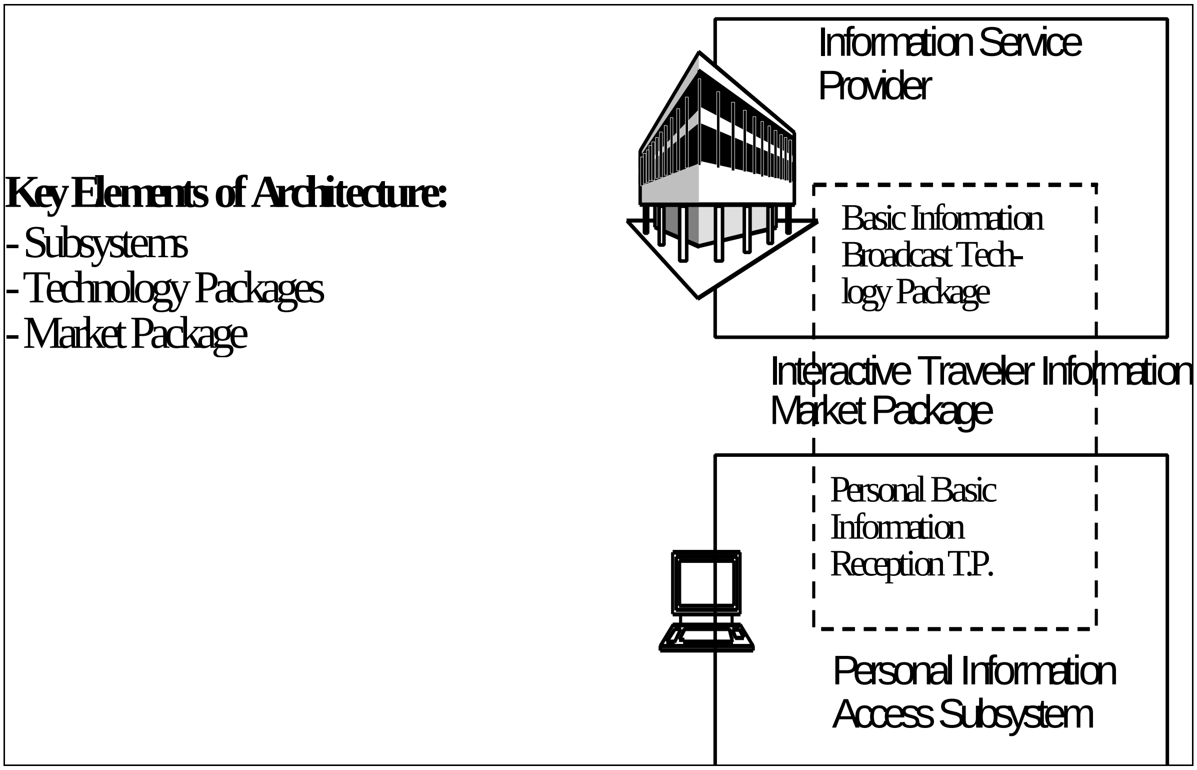

Figure 5. Relationship of Market Packages, Technology Packages, and Subsystems

The user services and market packages are traceable directly to the architecture definition. Once a market package is selected for implementation, the required subsystems, equipment packages, and interface requirements may be identified. The benefit of this approach is that it allows the agency or organization deploying the technology to first consider deployment options and later concentrate on those pieces of the architecture necessary to support the selected deployment.

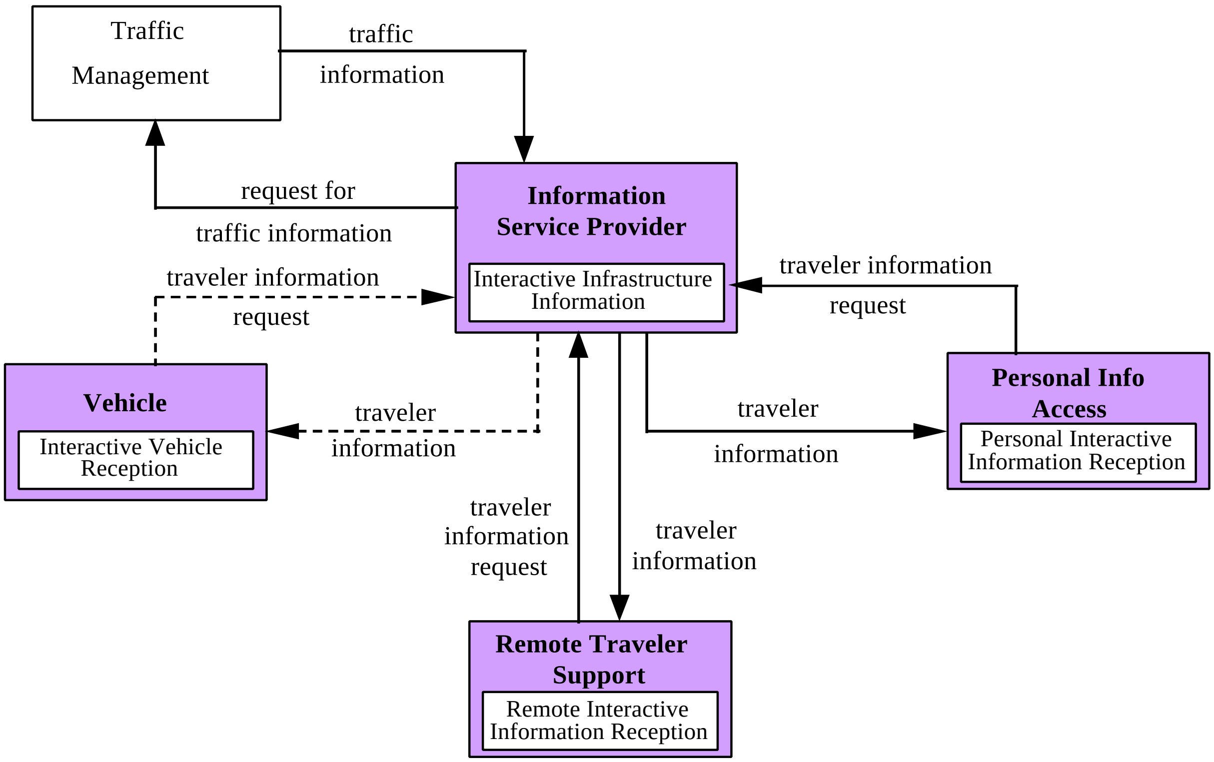

Figure 6. Interactive Traveler Information Market Package

Regional Overview

The Wilmington Region encompasses parts of New Hanover, Brunswick, and Columbus counties. The Wilmington Region has a population of approximately 259,000 people and includes the cities Wilmington, Carolina Beach, Wrightsville Beach, Castle Hayne, Shallotte, Long Beach, and Whiteville. The major cities, roadways and other key features of the Wilmington Region are shown in **Table 2**.

Table 2. Wilmington Region General Information

County	NCDOT Division	Population	Major Cities	Major Roads	Military/Universities
New Hanover	3	153,000	Wilmington	I-40	UNC-Wilmington
			Carolina Beach	US 17, US 74, US 117, US 421	
			Wrightsville Beach	NC 132, NC 133	
			Castle Hayne		
Brunswick	3	71,000	Shallotte		
			Long Beach	US 17, US 74	
				NC 87, NC 130, NC 179, NC 211	
				NC 904	
Columbus	6	35,000	Whiteville		
(~67%)				US 74, US 76	
				NC 130, NC 211, NC 904	

Overview of ITS in the Region

Although relatively new, many ITS deployments are either fully functional, in construction, or in the planning stages throughout the State. Included in these deployments is a signal system and several deployments to respond during hurricane evacuations.

The deployed, planned and programmed elements are shown schematically in **Figure 8**. This figure shows the relationships between the elements and the various management centers, as well as the current connections between the centers.

Hurricane Evacuation Plan

The eastern part of North Carolina is a frequent target of hurricanes. In order to effectively deal with these occurrences, NCDOT, along with other agencies, has developed a plan for evacuating coastal areas in the event of a hurricane. The evacuation plan incorporates one-way operation of Interstate 40, the major travel route to the Wilmington area. There is also a plan for deployments of ITS elements that will support evacuation. These elements include DMS HAR, CCTV, count stations, wind gauges, information kiosks, and traffic signal improvements throughout eastern North Carolina.

Figure 7 shows the primary evacuation routes from the coastal areas of North Carolina, along with Interstate 95, a major evacuation route from South Carolina. One-way operation of I-40 from Wilmington to Raleigh will greatly increase the capacity of that route in the eastbound direction, and thereby reduce the time needed to evacuate the Wilmington area. Major evacuation routes from the rural coastal area include U.S. 64, U.S. 264, and U.S. 70.

Table 3 includes provides a summary of the proposed ITS elements for hurricane evacuation.

Figure 7. Primary Evacuation Routes from the Coastal Areas of North Carolina

Table 3. Summary of the Proposed ITS Elements for Hurricane Evacuation

	Device Type							
County Name	**CCTV**	**HAR**	**DMS (OH)**	**DMS (PORT)**	**DMS (PED)**	**ATR**	**GATE**	**WIND**
Bertie				1		1		
Bertie/Martin		1		1				
Bladen/Robeson		1		1				
Brunswick	1	1	2					
Camden				2				
Carteret	1	1		2				2
Chowan		1		1			1	
Chowan/Bertie								1
Chowan/Washington								1
Craven		1	3					1
Cumberland	2	1	1					
Currituck		1		3				
Dare	4	3		2	3	3		1
Duplin	1	1		1				
Harnett	1		1					
Johnson	3	2	1		2			
Johnston	3	1	2	1				
Jones				1				
Lenoir				1				
Martin				1				
Nash	1	1		1				
New Hanover	3	2	1	2				
Pender				1				
Perquimans			1			1		
Sampson					1			
Sampson/Duplin					1			
Wake	7	1	2					
Washington		1					1	
Wayne		1		2				
Wilson	1							

Regional Strategic Deployment Plan Process

Meetings

To preparation for the Wilmington Regional Summit, two planning meetings were held. The first was a TCC meeting and was held on September 1, 1999. This was followed by a TAC meeting, which was held on October 28, 1999. The purpose of these meetings was to prepare and plan for the Wilmington regional summit. The minutes for these meetings are included in the Appendix. The TCC and TAC meetings provided an overview of the entire project as well as the process for the regional and statewide plans. The meetings included a discussion of project specific issues, including:

- The perception of ITS in the Region
- Comments on the proposed process
- Identification of the stakeholders

The discussion helped to identify some of the key aspects of the project that needed to be carried forward throughout the process.

Summits

Following the initial TCC and TAC meetings, a regional summit meeting was held on March 14, 2000.

The summit enabled people from different backgrounds, including transportation-related professionals, to learn more about ITS and provide input on the specific needs that can be met using ITS products and technologies. Attendees included mayors, city and state traffic engineers, and members of the news media. The minutes from this meeting are provided in the Appendix.

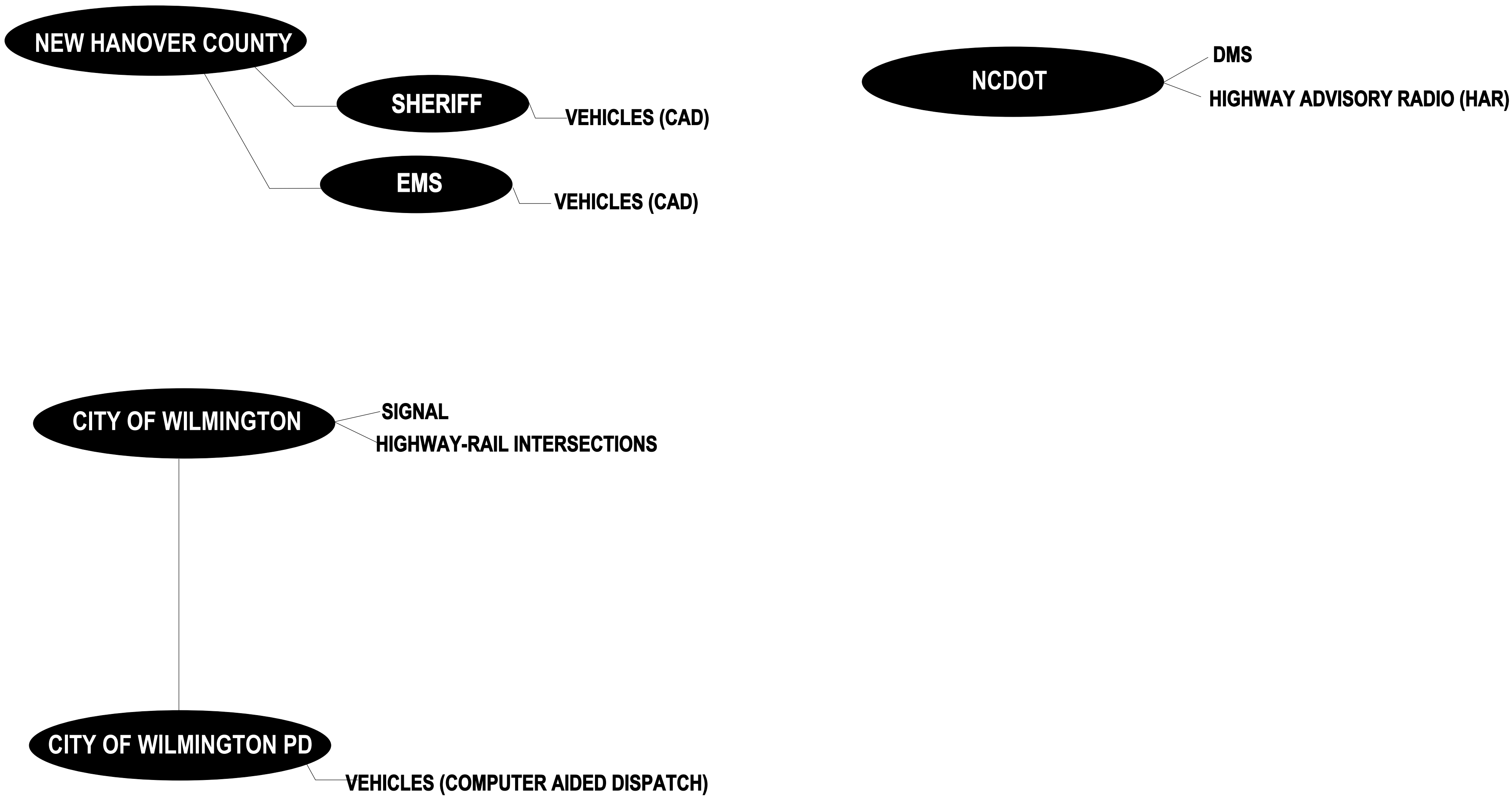

FIGURE 8 SCHEMATIC REPRESENTATION OF WILMINGTON REGION ITS ELEMENTS

Kimley-Horn and Associates, Inc.

Identification of Transportation Needs or Issues

As a result of the meetings, summits, and breakout groups, four key program areas for the Wilmington Region were identified:

- hurricane evacuation
- en-route driver information
- pre-trip travel information
- route guidance

The key transportation issues were identified based on the discussions of the various groups and the input from the Summit Meeting. Thirty specific issues were identified in the transportation summits. Of the 30 needs, the following five groupings or sub-categories were identified:

Traveler Information

- Lack of real time traffic information
- Lack of traveler information – via message signs
- Lack of traveler information – at rest areas and welcome centers
- Too few dynamic message signs with current traveler information
- Lack of access to traveler information through kiosks and television
- Lack of 24-hr, real time alternate route information
- Better directional signing, speed limit, pedestrian warnings
- 1-800 Central phone number for traffic information
- Link local, regional websites to NCSMARTLINK
- Link traffic information to local TV, Cable
- Better alternate route guidance
- Traveler Information Kiosks (@ Rest areas, hotels, shops, malls, Visitor Centers, airports, etc.)

Freeway Management

- Peak hour freeway congestion
- Reversible lanes for evacuation routes (eastbound lanes on I-40 for hurricane evacuation)
- Automatic Vehicle Location (AVL) Systems

Transit

- Lack of information on park-and-ride facilities
- Lack of readily available transit information to increase ridership
- Transit, Draw Bridge, and Emergency Vehicle Preemption
- Lack of widespread electronic transit fare payment systems, including multiple transit fare structure
- Low level of personal safety of transit users
- Advertise Rideshare Programs

Commercial Vehicle Operations

- Inefficient commercial vehicle clearance at points of entry
- Insufficient commercial vehicle monitoring for safety or equipment violations
- Lack of automated commercial vehicle compliance enforcement, including non-point of entry locations, with weigh in motion and CCTV surveillance
- Need better CV weight detection and enforcement
- Slow moving trucks
- HI STEP is needed to help prevent future accidents involving CV's and/or officers
- Need to reduce number of crashes involving CVs
- Need CVO and transit vehicle operating status/safety monitoring devices
- Dedicate lane for EMS, police, etc.

Several needs that were not identified in the Wilmington Regional summit were identified in one or more of the previous urban regional meetings. Some of these needs, and some identified in the urban summits, have been identified as linkages to statewide or "extra-regional" needs.

This information was grouped into "market packages" to develop a regional ITS architecture. This process is described in detail later in this report.

Regional Strategic Plan

The basic premise for this ITS strategic deployment plan is to identify the transportation problems and needs in North Carolina and to select ITS technologies that can be used to address these needs. ITS technology selection process begins with identifying appropriate The ITS user services. User services represent functions performed by ITS technologies and organizations for the direct benefit of the traveling public.

The National ITS program plan defines the term *users* as: "a wide range of individuals and organizations including drivers, travelers, service providers, and transportation policy makers." The NIA currently defines 31 user services. In addition the USDOT has developed the Advanced Rural Transportation System (ARTS) program to respond to more rural ITS needs. The ARTS program has identified an additional six users services for rural areas that are in the process of being approved for inclusion in the NIA. **Table 4** lists all 37 user services listed in the NIA and ARTS, and also provides a brief definition of each.

Table 4. ITS User Services **(*ARTS User Service)**

1	Pre-Trip Travel Information	*Provides information for selecting the best transportation mode, departure time, and route.*
2	En-Route Driver Information	*Provides advisories and in-vehicle signing for convenience and safety.*
3	Route Guidance	*Provides travelers with instructions on how to reach their destinations.*
4	Ride Matching and Reservation	*Makes ride sharing easier and more convenient.*
5	Traveler Services Information	*Provides a business directory, or "yellow pages," of service information.*
6	Traffic Control	*Manages the movement of traffic on streets and highways*.
7	Incident Management	*Helps quickly identify incidents and implement a response.*
8	Demand Management and Operations	*Supports policies to mitigate the environmental/social impacts of traffic.*
9	Emissions Testing and Mitigation	*Provides information for monitoring air quality.*
10	Highway Rail Intersection	*Provides improvements to automated crossing control systems.*
11	Public Transportation Management	*Automates operations, planning, and management of public transit.*
12	En-Route Transit Information	*Provides information on public transportation after the trips begins.*
13	Personalized Public Transit	*Provides flexibly routed transit to offer more convenient service.*
14	Public Travel Security	*Creates a secure environment for transportation patrons and operators.*
15	Electronic Payment Services	*Allows travelers to pay for transportation services electronically.*
16	CVO Electronic Clearance	*Facilitates domestic and international border clearance.*
17	Automated Roadside Safety Inspection	*Facilitates roadside inspections.*
18	On-Board Safety Monitoring	*Senses the safety status of a commercial vehicle, cargo, and driver.*
19	CVO Administrative Processes	*Provides electronic purchasing of credentials, etc.*
20	Hazardous Material Incident Response	*Provides immediate description of hazardous materials.*
21	Commercial Fleet Management	*Provides communication between drivers, dispatchers, and providers.*
22	Emergency Notification and Personal Security	*Provides immediate notification of an incident and immediate request for assistance.*
23	Emergency Vehicle Management	*Reduces incident response time for emergency vehicles.*
24	Longitudinal Collision Avoidance	*Helps prevent head-on, rear-end or backing collisions between vehicles, or between vehicles and other objects or pedestrians.*
25	Lateral Collision Avoidance	*Helps prevent collisions when vehicles leave their lane of travel.*
26	Intersection Collision Avoidance	*Helps prevent collisions at intersections.*
27	Vision Enhancement for Crash Avoidance	*Improves the driver's ability to see the roadway and objects that are on or along the roadway.*
28	Safety Readiness	*Provides warnings about the condition of the driver, vehicle, and roadway.*
29	Pre-Crash Restraint Deployment	*Anticipates an imminent collision and activates passenger safety systems before the collision occurs, or much earlier in the crash event than is currently feasible.*
30	Automated Vehicle Operation	*Provides a fully automated hands-off operating environment.*
31	Archived Data User Service	*Provides for automated historic data archiving and sharing.*
32*	Portable Traffic Management	*Traffic surveillance and control that is flexibly and speedily deployable, for highway and traffic conditions that are accidental, sporadic or seasonal.*
33*	Road Maintenance and Management	*The efficient maintenance and rapid repair of roads.*
34*	Seasonal Harvesting	*The coordination of intermodal transportation resources and agricultural production.*
35*	Economic Development (Business Viability)	*The improvement of transportation efficiency, the reduction of adverse transportation impacts.*
36*	Economic Development (Tourism)	*T the dissemination of information that promotes compatible enjoyment of parks other tourist sites, and services to tourists.*
37*	ITS Planning and Marketing Data	*The collection and processing of information derived from the operation and evaluation of ITS.*

Regional Plan Development Methodology

The objective of this task was to determine, based on stakeholder input, which of the 37 ITS user services need to be implemented in the Wilmington Region and how to phase their implementation (i.e., in the short- or long-term timeframes). Since delivering a user service takes more than just one piece of equipment, the ITS architecture groups equipment into market packages.

While user services help us define what is needed, their corresponding market packages describe how to provide those services. Each market package consists of a group of elements (equipment packages) that work together to deliver a particular user service. To identify the specific technology groups that will be needed to provide the selected user services, market packages corresponding to each selected user service were identified in this task.

The activities of this task were divided into three steps aimed at producing a well-defined, integrated user service plan:

Identification and prioritization of applicable user services based on previously identified transportation needs of the region and development of user services deployment timeframes
Development of specific user objectives and performance criteria
Selection of market packages

The following section describes the above steps in more detail. The remainder of this section of the report provides a complete description of each activity associated with these steps.

The first step in this task focused on identifying the user services appropriate for North Carolina based on previously identified regional needs. First, the original statements of problems and concerns gathered through stakeholder meetings in each of the summits were assembled into a comprehensive list. Next, this list of original, raw statements was reduced and refined through grouping of similar statements into concise need statements. This step also eliminated those problem statements not directly related to transportation issues that could be related to ITS. Lastly, these needs were placed in a separate category of non-ITS related needs. Lastly these concise need statements were matched with appropriate ITS user services.

The Wilmington Region’s transportation-related needs, identified in the previous section, were matched, or mapped, with the 37 applicable ITS user services, resulting in a preliminary set of user services to be deployed specifically in the Wilmington Region. Several overlapping needs that were identified in the other urban regions (Triad, Triangle and Metrolina) were carried over to the Wilmington Region.

These user services were prioritized based on the relative ranking of each related need. The Summit provided the needs ranking, in terms of importance, during the regional Summit. Based on the priority ranking of each user service and using the common objectives and overlapping functionality of the user services, preliminary short- and long-term deployment timeframes for groups of user services were identified.

In the next step, system objectives were defined for each identified user service. A system objective identifies the improvements in the system that can be expected to occur as a result of a successful implementation of a user service. To judge the degree of success of the implementation of the user services, including the effectiveness of the deployed service or technology in solving the original problem, a set of performance criteria was developed.

Finally, to begin defining the physical ITS architecture for each region and for the state, market packages corresponding to the selected user services were identified. The 63 currently defined ITS market packages are an important building block of the statewide ITS architecture definition process and represent specific portions of the architecture that may be required to satisfy the needs identified by North Carolina stakeholders.

Input Mapping to User Services

The transportation needs for the Wilmington region, as discussed in the previous section, were mapped to the User Services categories in the NIA. The user service mapping is shown in **Table 5.**

Ranking of Identified Needs

The prioritization of user services was based on the relative ranking of each of the 30 needs identified by the stakeholders. The Wilmington Region's transportation stakeholders, ranked the needs after the Regional Summit Meeting.

The assignment of the need rankings (shown in **Table 6**) to the matched user services was accomplished by summing the point scores of all the needs corresponding to each matched user service as shown in **Table 5**. **Table 6** shows the ranking of these needs by the involved in the ITS project from the Wilmington Region.

The score for each user service was expressed in percent of the total score (equal to the sum of scores for all user services), and plotted on a bar chart. **Figure 9** shows the resulting ranking of the user services receiving points. (The details of this methodology are provided in the Appendix).

The user services in **Figure 9**,were identified as most likely to achieve Strategic Planning success in the Wilmington region. This selection was not intended to exclude other user services as needed in specific areas. The list of user services does, however, represent recommendations of regional services on which the remainder of this strategic plan was based.

Table 5. Matching User Needs to User Services

ID#	WILMINGTON AREA NEEDS	1.1 Pre-trip Travel Information	1.2 En-route Driver Information	1.3 Route Guidance	1.4 Ride Matching And Reservation	1.5 Traveler Services Information	1.6 Traffic Control	1.7 Incident Management	1.8 Travel Demand Management	1.9 Emissions Testing And Mitigation	1.10 Highway-rail Intersection	2.1 Public Transportation Management	2.2 En-route Transit Information	2.3 Personalized Public Transit	2.4 Public Travel Security	3.1 Electronic Payment Services	4.1 Commercial Vehicle Electronic Clearance	4.2 Automated Roadside Safety Inspection	4.3 On-board Safety Monitoring	4.4 Commercial Vehicle Administrative Processes	4.5 Hazardous Material Incident Response	4.6 Commercial Fleet Management	5.1 Emergency Notification And Personal Security	5.2 Emergency Vehicle Management	6.1 Longitudinal Collision Avoidance	6.2 Lateral Collision Avoidance	6.3 Intersection Collision Avoidance	6.4 Vision Enhancement For Crash Avoidance	6.5 Safety Readiness	6.6 Pre-crash Restraint Deployment	6.7 Automated Vehicle Operation	7.1 Archived Data Function	8.1 Other	POTENTIAL PROJECTS
		User Services																																
		Travel And Traffic Management										Public Transportation				Electronic Payment	Commercial Vehicle Operations						Emergency Management		Advanced Vehicle Safety Systems							Information Management	Other	
1	Lack of real time traffic information	X	X									X																						Transit kiosks. Web-based transit information access. Bus stop transit schedule displays.
2	Lack of traveler information - Via Message Signs		X				X																											Variable Message Signs on freeways and arterials with frequent and accurate message updates.
3	Lack of traveler information - At rest areas and welcome centers	X		X		X						X																						Traveler information kiosks located at high-pedestrian traffic areas (office buildings, banks, stores, hotels, restaurants, visitor centers, chambers of commerce, etc.) Hardware, software, and partnership agreements with media for traveler information delivery.
4	Too few dynamic message signs with current traveler information		X				X																											Variable Message Signs on freeways and arterials with frequent and accurate message updates.
5	Lack of access to traveler information through kiosks and television	X										X																						Traveler information kiosks located at high-pedestrian traffic areas (office buildings, banks, stores, hotels, restaurants, visitor centers, chambers of commerce, etc.) Hardware, software, and partnership agreements with media for traveler information delivery.
6	Lack of 24-hr, real-time alternate route information		X	X																														VRAS - Voice Remote Access System to traveler information with touch button route and milepost selection. FM subcarrier incident location feeds to in-vehicle devices with map and alternate route databases. Centrally located alternate route database system. Commercial radio and HAR broadcasts with alt. route information. Internet based incident/closure location data with date, time, and alt. route suggestions.
7	Better directional signing, speed limit, pedestrian warnings		X	X			X																						X					
8	1-800 Central phone number for traffic information	X																														X		
9	Link local, regional websites to NCSMARTLINK	X				X																										X		
10	Link traffic information to local TV, Cable	X																														X		
11	Better alternate route guidance	X	X	X			X																									X		
12	Traveler Information Kiosks (@ Rest areas, hotels, shops, malls, Visitor Centers, airports, etc)	X		X		X					X																					X		
13	Peak hour freeway congestion						X																											Regional traffic control system (freeway management system with system detection, video monitoring, incident detection, ramp metering). Synchronization of ramp meter signals with adjacent traffic signals.
14	Reversible lanes for evacuation routes (eastbound lanes on I-40 for Hurricane evacuation)			X			X		X														X									X		
15	AVL Systems																															X	X	
16	Lack of information on park-and-ride facilities	X	X			X							X																					Transit kiosks. Web-based park-and-ride information. Voice remote access system park-and-
17	Lack of readily available transit information to increase ridership											X	X																					
18	Transit, Draw Bridge, and Emergency Vehicle Preemption						X						X											X										Signal pre-emption for emergency vehicles.
19	Lack of widespread electronic transit fare payment systems, including multiple transit fare structure											X				X																		Smart Card transit fare payment with single payment for multiple transfers and transit mode changes.
20	Low level of personal safety of transit users														X																			Audio and video monitoring at bus stops. Emergency phones at bus stops.
21	Advertise Rideshare Program				X							X																						Upgrades to transit public information system. Web and voice based rideshare systems tied to transit schedules.
22	Inefficient commercial vehicle clearance at points of entry																X																	Automated CV clearance at highway speeds at POEs using PrePass-like technologies.
23	Insufficient commercial vehicle monitoring for safety or equipment violations																		X															In-vehicle driver monitoring systems with wireless communications to dispatching center.
24	Lack of automated commercial vehicle compliance enforcement, including non-point of entry locations, with weigh in motion and CCTV surveillance																X	X	X															Strategically located, concealed WIM stations with associated CCTV surveillance cameras with wireless alerts to law enforcement. AVL for CV with random or permissive tracking by law enforcement.
25	Need better CV weight detection and enforcement																X	X																Non-POE WIM with automatic law enforcement notification.
26	Slow moving trucks						X										X																	Advanced warning signs during heavy truck times.
27	HI STEP is needed to help prevent future accidents involving CV's and/or officers						X												X						X	X	X	X	X					Collision avoidance systems in CVs and in passenger vehicles. Roadside speed displays. Speed enforcement.
28	Need to reduce number of crashes involving CVs						X												X						X	X	X	X	X					Collision avoidance systems in CVs and in passenger vehicles. Roadside speed displays. Speed enforcement.
29	Need CVO and transit vehicle operating status/safety monitoring devices																		X										X					In-vehicle system monitoring devices.
30	Dedicate lane for EMS, police, etc.						X																											Signing issue and AVL potential

Table 6. Coalition Ranking of Identified Needs (by Score)

ID#	Needs	Ranking
14	Reversible lanes for evacuation routes (eastbound lanes on I-40 for Hurricane evacuation)	1
4	Too few dynamic message signs with current traveler information	2
2	Lack of traveler information - Via Message Signs	3
5	Lack of access to traveler information through kiosks and television	4
3	Lack of traveler information - At rest areas and welcome centers	5
24	Lack of automated commercial vehicle compliance enforcement, including non-point of entry locations, with weigh in motion and CCTV surveillance	6
26	Slow moving trucks	7
29	Need CVO and transit vehicle operating status/safety monitoring devices	8
28	Need to reduce number of crashes involving CVs	9
25	Need better CV weight detection and enforcement	10
27	HI STEP is needed to help prevent future accidents involving CV's and/or officers	11
23	Insufficient commercial vehicle monitoring for safety or equipment violations	12
22	Inefficient commercial vehicle clearance at points of entry	13
1	Lack of real time traffic information	14
12	Traveler Information Kiosks (@ Rest areas, hotels, shops, malls, Visitor Centers, airports, etc)	15
6	Lack of 24-hr, real-time alternate route information	16
18	Transit, Draw Bridge, and Emergency Vehicle Preemption	17
13	Peak hour freeway congestion	18
11	Better alternate route guidance	19
7	Better directional signing, speed limit, pedestrian warnings	20
8	1-800 Central phone number for traffic information	21
10	Link traffic information to local TV, Cable	22
9	Link local, regional websites to NCSMARTLINK	23
30	Dedicate lane for EMS, police, etc.	24
16	Lack of information on park-and-ride facilities	25
15	AVL Systems	26
17	Lack of readily available transit information to increase ridership	27
19	Lack of widespread electronic transit fare payment systems, including multiple transit fare structure	28
21	Advertise Rideshare Program	29
20	Low level of personal safety of transit users	30

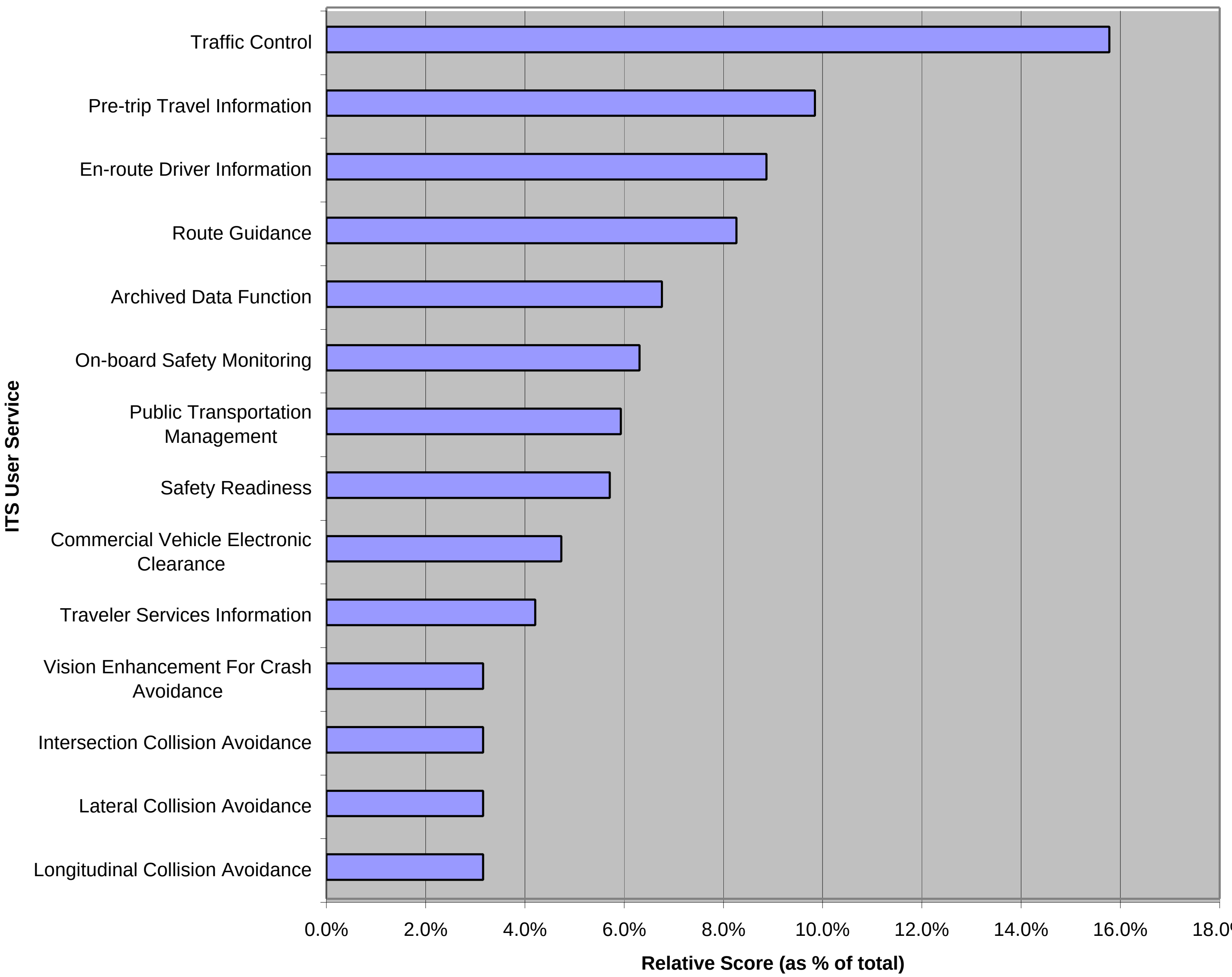

Figure 9. User Services Ranking (based on relative importance of associated needs)

Selection of Market Packages

The NIA defines the purpose of market packages addressing specific services that might be required by traffic managers, transit operators, travelers, and other ITS stakeholders. The market packages are tightly coupled with the architecture definition and represent the “building blocks” that can be deployed over time to efficiently achieve high-end ITS services. Several different market packages are defined for each major application area, which provides a palette of services at varying cost.

Market packages are also identified to segregate services, which are likely to encounter technical or non-technical challenges from lower risk services. For example, driver warning and vehicle control systems are defined as separate market packages due to the increased technical and non-technical risks associated with systems which dilute the driver’s direct control of the vehicle. This approach yields market packages that may be deployed early with low risk. Many of the market packages are also incremental so that more advanced packages can be efficiently implemented based on earlier deployment of more basic packages. In summary, market packages represent ITS services and implementation options that may be considered by system implementers.

The selection of appropriate market packages is an important step in the ITS strategic planning process. Historically, market packages were introduced in the planning process after user services, which, along with functional requirements, were the last steps in the process before architecture definition. The ITS deployment guidelines have evolved to include both additional steps and alternative paths for urban, regional, or statewide ITS strategic plan developments.

The objective of this task was to identify a set of candidate market packages for potential deployment in the Wilmington region of North Carolina. The NIA provides a matrix connecting the 37 user services and the 63 market packages. This matrix allows market packages and user services to be tracked in order to identify specific projects and their coverage of elements in the NIA.

Table 7 illustrates the matching of the user services previously identified to the market packages. The selected market packages corresponding to the transportation needs identified by the stakeholders are indicated with a “YES”. Linkages that exist, but are not applicable to the identified Wilmington Region stakeholder needs are indicated with a “NO”. The market packages selected correspond to the transportation needs identified by the stakeholders.

Note that 37 of the possible 63 market packages were identified as potentially deployable in the Wilmington region. This is due to the fact that deployment of several of the identified user services will require portions of numerous market packages. For example, the user service Traffic Control is matched with 11 market packages; similarly, the Economic Development user services are related to over 28 market packages. While this selection may at first sight appear too broad and indiscriminate, one must keep in mind that these market packages represent sets of specific technology applications, called equipment packages, that need not all be implemented to deploy a given user service.

Table 7. Matching Market Packages to Selected User Services

		User Services																															
	WILMINGTON	Travel And Traffic Management										Public Transportation Management				Electronic Payment	Commercial Vehicle Operations						Emergency Management		Advanced Vehicle Safety Systems							Information Management	Other
		1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	1.10	2.1	2.2	2.3	2.4	3.1	4.1	4.2	4.3	4.4	4.5	4.6	5.1	5.2	6.1	6.2	6.3	6.4	6.5	6.6	6.7	7.1	8.1
Market Packages		Pre-trip Travel Information	En-route Driver Information	Route Guidance	Ride Matching And Reservation	Traveler Services Information	Traffic Control	Incident Management	Travel Demand Management	Emissions Testing And Mitigation	Highway-rail Intersection	Public Transportation Management	En-route Transit Information	Personalized Public Transit	Public Travel Security	Electronic Payment Services	Commercial Vehicle Electronic Clearance	Automated Roadside Safety Inspection	On-board Safety Monitoring	Commercial Vehicle Administrative Processes	Hazardous Material Incident Response	Commercial Fleet Management	Emergency Notification And Personal Security	Emergency Vehicle Management	Longitudinal Collision Avoidance	Lateral Collision Avoidance	Intersection Collision Avoidance	Vision Enhancement For Crash Avoidance	Safety Readiness	Pre-crash Restraint Deployment	Automated Vehicle Operation	Archived Data Function	Other
ad1	ITS Data Mart																															NO	
ad2	ITS Data Warehouse																															NO	
ad3	ITS Virtual Data Warehouse																															NO	
apts1	Transit Vehicle Tracking											NO	YES	NO	NO																		
apts2	Transit Fixed-Route Operations											YES	YES																				
apts3	Demand Response Transit Operations											YES	NO	YES																			
apts4	Transit Passenger and Fare Management												NO			YES																	
apts5	Transit Security											YES			YES																		
apts6	Transit Maintenance											NO																					
apts7	Multi-modal Coordination						YES		YES			YES																					
apts8	Transit Traveler Information											YES	YES																				
atis1	Broadcast Traveler Information	YES	YES										YES																				
atis2	Interactive Traveler Information	YES	YES		NO	YES							NO	NO		YES																	
atis3	Autonomous Route Guidance		YES	YES																													
atis4	Dynamic Route Guidance		YES	YES		YES		YES					YES																				
atis5	ISP Based Route Guidance	YES	YES	YES												NO																	
atis6	Integrated Transportation Management/Route Guidance		YES	YES												NO																	
atis7	Yellow Pages and Reservation	NO	NO		NO	YES							NO			NO																	
atis8	Dynamic Ridesharing	NO	NO	NO	YES				YES				NO	YES		NO																	
atis9	In Vehicle Signing		YES				NO				NO																						
atms01	Network Surveillance						YES																										
atms02	Probe Surveillance						NO																										
atms03	Surface Street Control						YES	YES			NO																						
atms04	Freeway Control						YES	YES	NO																								
atms05	HOV Lane Management						NO		NO																								
atms06	Traffic Information Dissemination						YES				NO																						
atms07	Regional Traffic Control						YES																										
atms08	Incident Management System							YES																									
atms09	Traffic Forecast and Demand Management						YES		NO																								
atms10	Electronic Toll Collection															YES																	
atms11	Emissions Monitoring and Management									NO																							
atms12	Virtual TMC and Smart Probe Data		NO				NO	NO																									
atms13	Standard Railroad Grade Crossing										YES																						
atms14	Advanced Railroad Grade Crossing										NO																						
atms15	Railroad Operations Coordination										NO																						
atms16	Parking Facility Management								NO																								
atms17	Reversible Lane Management						YES																										
atms18	Road Weather Information System		YES				YES	YES																									
atms19	Regional Parking Management								NO																								
avss01	Vehicle Safety Monitoring																												NO	NO			
avss02	Driver Safety Monitoring																												NO				
avss03	Longitudinal Safety Warning																								NO				NO				
avss04	Lateral Safety Warning																									NO			NO				
avss05	Intersection Safety Warning										NO																NO		NO				
avss06	Pre-Crash Restraint Deployment																												NO	NO			
avss07	Driver Visibility Improvement																											NO					
avss08	Advanced Vehicle Longitudinal Control																								NO								
avss09	Advanced Vehicle Lateral Control																									NO							
avss10	Intersection Collision Avoidance										NO																NO						
avss11	Automated Highway System																														NO		
cvo01	Fleet Administration			YES																		YES											
cvo02	Freight Administration																				NO												
cvo03	Electronic Clearance																NO			YES													
cvo04	CV Administrative Processes																YES			YES													
cvo05	International Border Electronic Clearance																NO			NO													
cvo06	Weigh-In-Motion																YES																
cvo07	Roadside CVO Safety																	YES															
cvo08	On-board CVO Safety																		NO														
cvo09	CVO Fleet Maintenance																		NO			YES											
cvo10	HAZMAT Management							NO													YES	YES											
em1	Emergency Response																						NO	YES									
em2	Emergency Routing						YES																	YES									
em3	Mayday Support																						NO	NO									

Wilmington Region ITS Architecture

The ITS architecture is a framework that describes what a system does and how it does it. The architecture identifies the functions to be performed by the system, allocates these functions to subsystems, and defines the flows of information and the interfaces between the subsystems and components. This chapter describes the process of developing the Wilmington region architecture.

The national ITS plan originally defined a series of short-, medium- and long-term deployment timeframes for ITS. A number of years have passed since this timeframe was developed, and the initial goal was to match schedules with the reauthorization of ISTEA. This schedule reflected FHWA's desire to implement, as quickly as possible, visible and effective ITS projects that would stimulate public support for additional funding for future deployment programs.

For the purposes of this regional ITS plan, and taking into account that the ISTEA reauthorization occurred when TEA-21 was passed in 1998, the deployment timeframes for a regional implementation of selected user services are based on anticipated funding, need, and lead-time for the typical planning, design, and implementation schedules for transportation projects.

The following deployment timeframes have been identified for the Wilmington Regional ITS Plan, consistent with the other regional plans in North Carolina:

Short-Term	through fiscal year 2005
Long-Term	2006 through fiscal year 2010

General Description of ITS Architecture

The ITS architecture is comprised of two technical layers: a transportation layer and a communications layer. The transportation layer involves the various transportation-related processing centers, distributed roadside equipment, vehicle equipment, and other equipment used by the traveler to access ITS services. The communications layer provides for the transfer of information between the transportation layer elements. The transportation and communication layers together form the *architecture framework* that coordinates overall system operation by defining interfaces between equipment that may be deployed by different procuring and operating sectors.

The transportation layer involves 19 interconnected subsystems as shown in **Figure 10**. A complete description of each subsystem, along with its architecture diagram, is provided in the national architecture documents.

In general, the communication layer consists of two components: one wireless and one wireline. The transportation layer is supported by one or both of these components. The wireline portion of the network can be manifested in many different ways, and most of them are implementation dependent.

A simplified view of the communications interface is provided in the Very Top Level Architecture Interconnect Diagram in **Figure 10.**

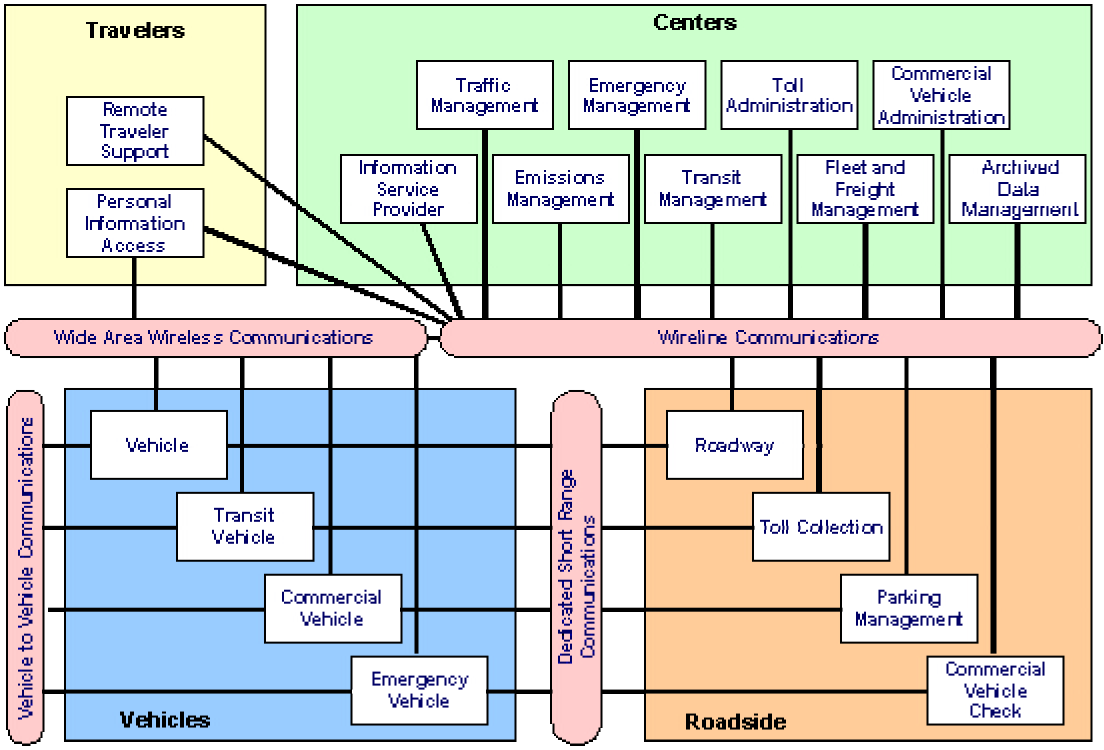

Figure 10. Top Level Architecture Interconnect Diagram.

Another element of the architecture is the Institutional layer, which documents the policies, funding incentives, working arrangements, and jurisdictional structure that supports the transportation and communication layers of the architecture. The institutional layer describes who has responsibility for deployment of the specific market packages and individual ITS projects and programs. It also identifies opportunities for public-public and public-private partnerships that would be necessary for successful deployment and/or operations and maintenance.

Recommended ITS Physical Architecture

The ranked user needs facilitated the identification of market package selection. Candidate technologies, projects and concepts to meet the transportation needs were identified. Based on this input, market packages for the selected user services were identified, as was the priority in terms of short-and long-term projects. The resulting market package deployment within each of the applicable user services is summarized in **Table 8**.

S – Short-Term Project/Market Package
L – Long-Term Project/Market Package

Table 8. Market Package Deployment, by Timeframe

	WILMINGTON	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.10	2.1	2.2	2.3	2.4	3.1	4.1	4.2	4.4	4.5	4.6	5.2
	Market Packages	Pre-trip Travel Information	En-route Driver Information	Route Guidance	Ride Matching And Reservation	Traveler Services Information	Traffic Control	Incident Management	Travel Demand Management	Highway-rail Intersection	Public Transportation Management	En-route Transit Information	Personalized Public Transit	Public Travel Security	Electronic Payment Services	Commercial Vehicle Electronic Clearance	Automated Roadside Safety Inspection	Commercial Vehicle Administrative Processes	Hazardous Material Incident Response	Commercial Fleet Management	Emergency Vehicle Management
apts1	Transit Vehicle Tracking											**YES**									
apts2	Transit Fixed-Route Operations										**YES**	**YES**									
apts3	Demand Response Transit Operations										**YES**		**YES**								
apts4	Transit Passenger and Fare Management														**YES**						
apts5	Transit Security										**YES**			**YES**							
apts7	Multi-modal Coordination						**YES**		**YES**		**YES**										
apts8	Transit Traveler Information										**YES**	**YES**									
atis1	Broadcast Traveler Information	**YES**	**YES**									**YES**									
atis2	Interactive Traveler Information	**YES**	**YES**			**YES**									**YES**						
atis3	Autonomous Route Guidance		**YES**	**YES**																	
atis4	Dynamic Route Guidance		**YES**	**YES**		**YES**		**YES**				**YES**									
atis5	ISP Based Route Guidance	**YES**	**YES**	**YES**																	
atis6	Integrated Transportation Management/Route Guidance		**YES**	**YES**																	
atis7	Yellow Pages and Reservation					**YES**															
atis8	Dynamic Ridesharing				**YES**				**YES**				**YES**								
atis9	In Vehicle Signing		**YES**																		
atms01	Network Surveillance						**YES**														
atms03	Surface Street Control						**YES**	**YES**													
atms04	Freeway Control						**YES**	**YES**													
atms06	Traffic Information Dissemination						**YES**														
atms07	Regional Traffic Control						**YES**														
atms08	Incident Management System							**YES**													
atms09	Traffic Forecast and Demand Management						**YES**														
atms10	Electronic Toll Collection														**YES**						
atms13	Standard Railroad Grade Crossing									**YES**											
atms17	Reversible Lane Management						**YES**														
atms18	Road Weather Information System		**YES**				**YES**	**YES**													
cvo01	Fleet Administration			**YES**																**YES**	
cvo03	Electronic Clearance																	**YES**			
cvo04	CV Administrative Processes															**YES**		**YES**			
cvo06	Weigh-In-Motion															**YES**					
cvo07	Roadside CVO Safety																**YES**				
cvo09	CVO Fleet Maintenance																			**YES**	
cvo10	HAZMAT Management																		**YES**	**YES**	
em1	Emergency Response																				**YES**
em2	Emergency Routing						**YES**														**YES**

Recommended Projects and Technologies

This section summarizes the technology recommendations that support the short-and long-term deployment of ITS in the Wilmington Region. These are the same deployment horizons used elsewhere in this report. The following list summarizes these technologies:

Short-Term (2000 - 2006) Technologies
1. IMAP Vehicle
2. Signal Preemption for Emergency Vehicles
3. Automatic Vehicle Location (AVL) for Transit
4. HAR
5. Website

Long-Term (2006 - 2011) Technologies
1. Traffic Signal System
2. Reversible Lanes
3. Transit Priority
4. DMS
5. Kiosks
6. ATIS Enhancements

Technologies Especially Applicable to Urban Areas

Traveler Information Kiosks – Kiosks provide users with free access at rest areas, welcome centers, etc. to a wide range of information available from state transportation agencies, tourist destinations and organizations, local governments, and downloaded information from the Web. In addition, users can check their e-mail, surf the Web, or use a search engine for a charge. Three types of kiosks have been developed for these applications: sit-down, stand-up, or stand-alone countertop unit. Some of these units are designed to supplement traveler counselors available at most state welcome centers (Source: Arizona DOT).

World Wide Web – The Web provides access to a universe of information, some of which (weather, road closures, etc.) can be downloaded from other sites. Applications are for users prior to departure, although en-route information can be provided at kiosks in welcome centers.

In-vehicle Automatic Vehicle Location (AVL) System – Integrated units featuring a global positioning satellites (GPS) receiver, cellular digital packet data (CDPD) modem, processor, keypad, display and sensor interface are available. Some units are designed to interface to vehicle sensors and controls such as road temperature, material spreaders via standard RS-232/RS-485 interface, and can detect plow or sweeper up/down status. Functions include operator log-on, vehicle position and transmitting, emergency alarms, two-way messaging, and sensor data collection and storage. (Source: Orbital Sciences Corp., Germantown, Maryland.)

Vehicle Tracking and Information System Software - These systems are integrated with the in-vehicle device referenced above, and include the mapping, messaging, reporting, playback and vehicle information functions. Reporting takes place through an open database connectivity (ODBC) compliant database, and information includes such data as total operating miles, deadhead miles, material spread (maintenance vehicles), road temperatures, etc. (Source: Orbital Sciences Corp., Germantown, Maryland.)

Traffic Sensing System – Magneto-inductive sensors are installed in the pavement and transduce small magnetic charges into inductive charges. These charges permit data collection for monitoring traffic. These systems consist of sensors, sensing electronics, cabling, and installation components. They support traffic data collection and storage to monitor speed, number of vehicles by classification, lane occupancy, and vehicle length. (Source: 3M Safety and Security Systems Division.)

Surveillance and Delay Advisory System (SDAS) - The SDAS consists of three data collection technologies: WIM, video-based sensing, and spot speed measurements. The system gathers data from a construction zone (the area around a special venue such as a tourist destination), computes travel times and delays through the zone of interest, and transmits delay messages to motorists traveling through the zone. (Source: Office of Safety Research and Development, FHWA, McLean, Virginia.)

DMS - Special attention for use of DMS in urban areas include traffic congestion advisories, tourist information, and various events - such as duration, size, and severity.

Description of Strategic Plan Projects

This Wilmington Regional ITS Strategic Plan has identified the needs of the Wilmington region's transportation stakeholders, and has matched them, where possible, to one or more ITS market packages, each representing an ITS solution. Of the 63 market packages currently defined in the NIA, 37 were identified as suitable for deployment in the region. By identifying the desired implementation horizon for each of the 37 selected market packages technology deployment phasing was developed. The recommended ITS solutions were once again cross-checked against the identified user needs, resulting in a more complete set of recommendations.

This section lists the technologies that should be deployed to achieve the desired functionality of each selected market package. The project title, description, and estimated cost of each deployment is listed. In addition, the schematic diagram of the existing, planned and programmed ITS deployments in the region have been modified to show the proposed short- and long-term deployments. This modified schematic is shown in **Figure 11**.

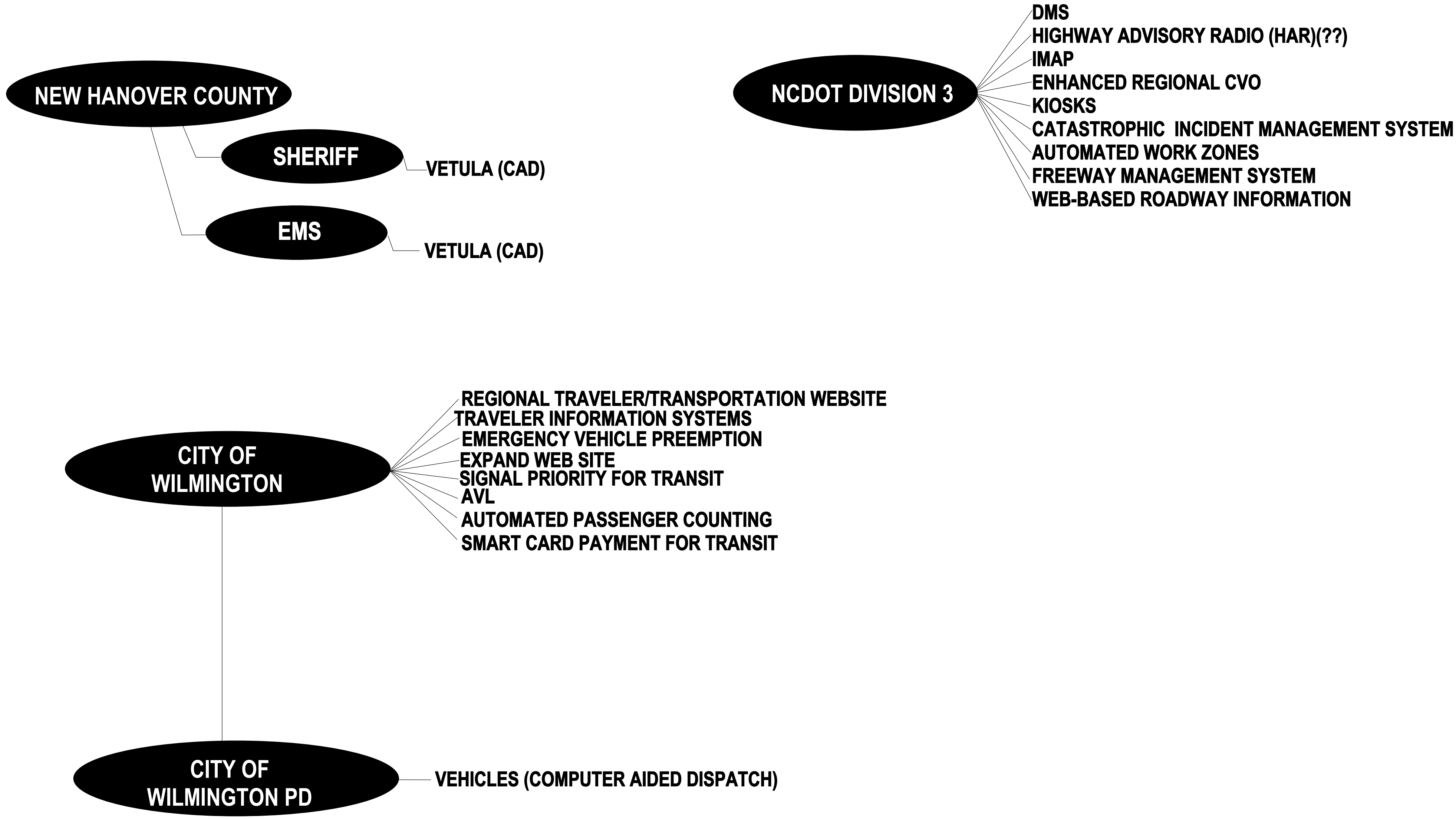

FIGURE 11 SHORT- AND LONG- TERM ITS DEPLOYMENT IN THE WILMINGTON REGION

Kimley-Horn and Associates, Inc.

Short-Term Projects

The following projects are recommended for short-term deployment in the Wilmington region. The projects are grouped according to systems. All costs shown are assuming year 2001 dollars.

Freeway/Incident/Event Management

Catastrophic Incident Management System. The coastal location of the Wilmington region necessitates the development of an evacuation plan in the case of a hurricane or other natural disaster. A reversible lane system on I-40 to provide additional capacity in the eastbound direction is a major part of this plan, along with the timely dissemination of weather, shelter, and evacuation information to the public.

The planning phase for developing a Catastrophic Incident Management System is already underway. This system requires the coordination of many agencies, including NCDOT, county, and local governments who will have to work closely together to coordinate an evacuation. At this stage, planning must be done to obtain and store the necessary portable equipment for lane control and traveler information. This equipment must be inventoried and maintained at convenient locations where it can be easily deployed in emergencies. Deployment procedures will be prepared so that the necessary agencies can be activated promptly in the event of an emergency.

Dynamic Message Signs. There is a need for motorists on major highways and arterials to have frequently updated information regarding road construction, incidents, and road conditions (especially relating to weather conditions). Signs will be installed at 10 sites in the Wilmington region. The anticipated cost for these improvements is $2,000,000.

Traffic Control

Signal Preemption for Emergency Vehicles. One of the issues identified through the stakeholders' involvement process is the need to improve the response time for emergency vehicles to both reach the scene of an incident as well as to return to a hospital or emergency room. The local agencies have already installed 3M Opticom® equipment in the area, and all new emergency vehicle preemption equipment will be the same. A four-way installation of an Opticom® system costs approximately $7,000. These will be installed on an as-needed basis throughout the region.

Transit

Bus Automatic Vehicle Location (AVL) System. The busses in the region will be outfitted with AVL systems to permit tracking and enhanced data collection. In addition, an automatic vehicle identification (AVI) system will be implemented to work with the AVL for a more comprehensive tracking and scheduling system. Finally, these two systems will be tied into on-bus systems that permit automatic passenger counters. The anticipated cost to outfit the busses with this system and provide central software in the Wilmington Region is $500,000.

Traveler Information

Regional Traveler/Transportation Website. NCDOT will develop a website or set of pages at an existing website to provide static travel information. This information may include transit schedules, fares and routes, published road closures, traffic policies, major generator and special event information, rideshare matching information and links to FAMPO, NCSmartLink, other city and NCDOT websites. This project is anticipated to cost $50,000 beyond the development costs being borne internally by NCDOT for various ITS web development projects.

Traveler Information System. A clearinghouse will be established to store real-time data for traveler information. This system will include data from system detectors, intersections, detector stations, posted incident reports, IMAP incident reports, and real time bus schedule information. This information will also be accessible from a central location, whether it is stored locally or remotely. The development of this clearinghouse will be used in kiosks and websites, with the development geared for long-term projects, such as a voice activated telephone system. The anticipated cost to develop this clearinghouse is $100,000.

Web-Based Roadway Information. As mentioned previously, NCDOT is in the process of developing a web-based real-time regional roadway information system to inform motorists of short-term and long-term road closures. This project will all be done internally to NCDOT, so all of the costs are internal to NCDOT.

Commercial Vehicle Operations

CVISN (Commercial Vehicle Information Systems and Networks). CVISN is the use of ITS information system elements, which support commercial vehicle operations (CVO). This includes a network of information systems owned and operated by governments, carriers and other stakeholders. The goal of the CVISN process is to use information technologies and networks to transfer credentials concerning commercial vehicles to reduce the time and energy costs typically associated with this process. NCDOT has been very actively working to implement CVISN statewide. This includes enforcement and electronic credentials. Some of the projects that are currently underway within the CVISN and ITS/CVO programs include:

Web Credentials. NCDOT is in the process of preparing electronic credentials on the web for commercial vehicle operators. A portion of the site is already operational, however the electronic credentials is still under development. This project is being done internally to NCDOT so there are no development costs.

Truck Presence Detection. NCDOT is presently implementing an automated system in the Charlotte area to identify trucks on alternate routes that are using those alternate routes to bypass weigh and inspection stations.

Mobile Inspection. NCDOT and the Department of Revenue are deploying a fleet of vehicles that can check credentials and perform truck inspections remotely throughout the Charlotte area. This fleet, called Wolf Packs, will be used to identify non-compliant trucks and trucks that are using alternate routes to avoid weigh and inspection stations.

Safety

Automated Work Zones. NCDOT is in the process of purchasing equipment that provides worker safety in work zones. This equipment consists of standard off-the-shelf packages that include portable speed and classification detection, speed warning signs, communication (via cellular telephone or radio) to alert police of speeders in a work zone, and, possibly, automatic enforcement measures.

Long-Term Projects

Freeway/Incident/Event Management

Catastrophic Incident Management System. In the long-term time frame, the Catastrophic Incident Management System will be expanded to include permanent infrastructure, such as signage and lane control equipment.

Freeway Management System. The short-term project involved installation of dynamic message signs in the Wilmington area. In the long-term, the freeway management system will be expanded to include detection, video monitoring, and ramp metering. The anticipated cost for these improvements is $2,000,000.

Transit

Signal Priority for Transit. There is an important need to provide a time savings for transit passengers along key transit corridors, at drawbridges, and through the CBD. A transit priority system for busses throughout the region will be deployed. This system will use the same receivers as the emergency vehicle preemption system. This hardware for the system will cost approximately $330,000. Implementation will be the responsibility of each agency.

In addition to the hardware, a regional study is required identifying key corridors and intersections where transit priority would provide the greatest benefit. At the locations where it is identified that transit priority will provide a benefit, the signals need to be reviewed for timing and operations to determine the appropriate priority treatment. Additionally, the timing modifications need to be prepared for each location to ensure each agency implements transit priority according to plan. This study and all of the signal modification plans is anticipated to cost $400,000.

Smart Card Payment System. A regional electronic payment system will be implemented that permits the same method of payment for all transit systems in the region. In addition to permitting travelers to use multiple bus systems without a complicated payment system, Smart Cards allow the various transit and planning agencies to better track ridership, transfers, and other information that can be used in the planning for future transit enhancements. The anticipated project cost is $250,000.

Traveler Information

Kiosks at Major Public Venues. NCDOT and the cities in the Wilmington Region will develop and install five (5) kiosks that use web-based technologies to link to the websites in the area that display local traffic and event information. In addition, these kiosks will display information of interest for tourists, including destinations, lodging, restaurants, and information centers. Potential locations include regional malls, rest areas, visitors' bureaus, chambers of commerce, arenas and coliseums, hotels, racetracks, convention centers and others.

Kiosks provide NCDOT the opportunity to enter into ventures with private entities in two ways. The first is by selling or leasing kiosks at locations that are not public facilities. This may include large employers, malls, or hotels. In addition, if additional kiosks are requested at locations, they may be sold or leased as well. The second opportunity is to permit the generation of kiosk operating revenue by either selling advertising or licensing the kiosks. This would permit NCDOT to recover some of the costs of providing the data and hosting websites.

The cost of installing 5 kiosks throughout the Wilmington region is approximately $300,000. There are additional costs associated with the long-term operations of kiosks, especially as more are added, for updating information and adding bandwidth.

The development costs of the kiosk content needs to be shared amongst the many interested parties. Traffic and transit data is only a small portion of the information that is available, and is typically the least used. The most used information is concerning local interests and directions to destinations. Therefore, the development costs of the content needs to be borne by those who will benefit the most: tourist destinations, restaurants, and hotels.

Expand the Traveler Information System. The traveler information system identified as a short-term project limits the user input to selecting bus routes and identifying "hot spots" along major routes. As a long-term project, NCDOT will expand the system to provide additional real-time information, such as transit arrival, estimated travel times and video images from Wilmington. The expansion of this system, with regard to integration and web site development (including hardware) is estimated to cost $250,000.

Project Summary

A summary of the aforementioned projects and their estimated cost are shown in **Table 9**.

Table 9. Summary of ITS Projects and Estimated Costs (based on year 2001 dollars)

Short-Term Projects			Long-Term Projects		
Description		**Cost ($000)**	**Description**		**Cost ($000)**
ATMS			**ATMS**		
S-1	Catastrophic Incident Management System	***	L-1	Extension of Catastrophic Incident Management System	***
S-2	Dynamic Message Signs	$2,000	L-2	Freeway Management System	2,000
S-3	Signal Preemption for Emergency Vehicles				
	Subtotal	$2,000		**Subtotal**	$2,000
APTS			**APTS**		
S-4	Advanced Transit System	$500	L-3	Transit Priority	$730
			L-4	Smart Card Technology	$250
I	**Subtotal**	$500	**Subtotal**		$980
ATIS			**ATIS**		
S-5	Regional Traveler/ Transportation Website	$50	L-5	Kiosks at Major Public Venues	$300
S-6	Traveler Information System	$100	L-6	Expansion of Traveler Information System	$250
S-7	Web-Based Roadway Information	***			
	Subtotal	$150		**Subtotal**	$550
CVO					
S-8	Web Credentials	***			
S-9	Truck Presence Detection	***			
S-10	Weigh in Motion Sites	$200			
S-11	Mobile Inspection	***			
Subtotal		$200			
Safety					
S-21	Automated Work Zones	***			
Subtotal		$0			
Total Short-Term		$2,850	**Total Long-Term**		$3,530
Anticipated Annual O&M Costs (8% of Total Short-Term)		$228	**Anticipated Annual O&M Costs** (8% of Total Long-Term)		$122
Total 20-year Estimated Costs			**$6,380**		
**No direct costs					
***Costs are borne internally by NCDOT					

Operational Concepts

A primary objective of the ITS deployments is to provide operational coordination across jurisdictional lines. Unlike the Triad, Triangle, and Metrolina regions — where there are large regional operations centers either existing or planned, and there are multiple local jurisdiction — the Wilmington Region only consists of the Wilmington, with smaller ITS deployments in surrounding counties and cities (especially with the hurricane evacuation system) Although this makes an operational plan easier in that there is only one entity with traffic management responsibilities, there is no local, regional backup to either the overall system or the individuals responsible for day-to-day operations.

In addition to traffic management needs, the Wilmington ITS Planning Region will benefit greatly from an integrated emergency response and dispatch system that incorporates all of the local systems. Local operations and database management benefits will be magnified by the sharing of information.

Following the development of this deployment plan, a regional operations plan needs to be developed that ties in operating procedures for systems throughout the region. This plan will include an incident management plan, with set responses for incidents throughout the region, procedures on working with various emergency personnel, and directions on how to work with the many different traffic management and signal systems in the region. This plan needs to be tied into the statewide plan to provide for the backup for both the system and personnel on a statewide level.

The agencies in the Wilmington Region, and their primary responsibilities are:

NCDOT – Wilmington area
- -Freeway Management
- -Regional Traveler Information – Website development, kiosk traffic information, etc.
- -Highway Advisory Radio
- -Major Event/Incident coordination

NCDOT – Statewide
- -Statewide Coordination
- -Statewide Traveler Information – Website, etc.

City of Wilmington
- -Traffic Signal Control/Systems
- -Wilmington Transit System
- -Traveler Information – Local issues and attractions, local traffic information, etc.

City of Wilmington Police Department
- -Emergency Management
- -Enforcement

New Hanover County Sheriff
- -Emergency Management
- -Enforcement

Benefits of ITS Systems

The benefits of ITS deployment are difficult to measure by simple quantitative analysis. An integrated ITS deployment program can include safety improvements, delay reduction, cost savings, capacity improvements, customer satisfaction, energy consumption reduction, and positive environment impacts. Municipalities throughout the United States are already seeing benefits from existing deployments. This benefit analysis reviews the existing deployments for various short and long term projects recommended for the Wilmington Region and provides real-world examples of benefits being realized by other municipalities. Quantifiable benefits for air quality monitoring can be obtained by following the Federal Highway Administration August 1999 report *Off-Model Air Quality Analysis – A Compendium of Practice* which is included in the Appendix. The following examples illustrate true potential application of the Wilmington Region ITS deployment plan.

Freeway/Incident/Event Management

There are three major ITS functions that make up Freeway Management Systems (FMS). These include monitoring and controlling freeway operations and providing current traffic information to motorist. The most common ITS devices used for monitoring and control include camera surveillance and ramp metering. Where variable message signs, updated web sites and highway advisory radio are commonly used to provide traffic information to the motorist. A traffic management center (TMC), the control center for the various ITS deployments, is responsible for monitoring freeway conditions and dispersing the information to motorist. Although FMS are most effective when used in conjunction with incident management and transit management systems, when used by themselves, they can make a substantial difference in increasing average speeds, reducing travel time, minimizing stop delays and reducing accident rates.

IMAP

The Incident Management Assistance Patrol are emergency traffic patrol vehicles equipped to aid minor breakdowns, push or tow vehicles, and reposition and move trailers. The purpose of this program is to respond as quickly as possible to debilitated vehicles to minimize the impact on traffic flow. When additional equipment is added such as computer aided dispatch systems, global positioning systems and mobile changeable message signs, patrols can get the job done faster. Programs like these also benefit the environment by restoring traffic flow and minimizing idling vehicle emissions. Additionally, this program provides an added measure of safety and security to the public.

Refer to the Off-Model Air Quality Analysis: A Compendium of Practice included in the appendix of this report for analyzing air pollution reduction with incident management.

Ramp Metering

Ramp meters, an integral ITS deployment used in freeway management systems, have proven to be a valuable tool in controlling traffic while improving flow rates, reducing travel times, emissions and fuel consumption. They also improve the safety of merging traffic while reducing accidents.

A good example of benefits obtained from ramp metering is demonstrated by the collection of data obtained from TMCs around the country for various ramp metering deployments. Survey results demonstrated that ramp meters have increased average speeds between 16% and 62% while reducing travel time by an average of 48%. Also, the data shows TMC's increased throughput between 8% to 22% while demand increased by 17% to 25%. With the increase in demand, the ramp meters have successfully reduced accidents by 15% and 50%[4]. Below are specific examples of ITS benefits from successful nationwide FMS deployments.

- Portland, Oregon: 58 ramp meters, 43% accident reduction, 39% travel time reduction, 25% demand increase, 60% increase in speed.
- Minneapolis/St. Paul, MN: 6 ramp meters, 5 miles of instrumented freeway, 24% accident reduction, 38% accident rate reduction, 16% increase in speed.
- Seattle. WA: 22 ramp meters, 52% decrease in travel time, 39% decrease in accident rate, 86% increase in demand.
- Denver, CO: 5 ramp meters, 50% accident reduction, 18.5% demand increase.
- Detroit, MI: 28 ramp meters, 50% accident reduction, 8% increase in speed, 12.5% increase in demand.
- Austin, TX: 3 ramp meters, 2.6 miles of instrumented freeway, 60% increase in speed, 7.9% increase in demand.
- Long Island, NY: 70 ramp meters, 128 miles of instrumented freeway, 15% accident reduction, 9% increase in speed.

Ramp metering alone has shown to produce a favorable benefit cost ratio. In Minneapolis, an evaluation of the ramp metering deployments showed that benefits of $40 million compared to total costs to implement ramp metering at $2.6 million, yielded a benefit cost ratio of 15:1[5].

Implementing a FMS has also proven to be more cost effective in improving freeway operations than widening the freeway. As an approximate comparison, freeway widening costs $2 million per lane-mile while a complete implementation FMS of an urban corridor costs $500,000 per freeway mile plus the cost

[4] Robinson, J. and Piotrowicz., "Ramp Metering Status in North America, 1995 Update," Federal Highway Administration, June 1995

[5] SRF Consulting Group, Inc., N.K. Friedrichs Consulting, Inc. "Twin Cities Ramp Meter Evaluation," Minnesota Department of Transportation, February 2001.

of a freeway management center[6]. This amounts to approximately 2:1 benefit cost ratio not including costs for the TMS. Moreover, if the existing freeway is four lanes, implementing a FMS could add about half the capacity of an additional lane at about 1/8 the cost of adding a lane.

For more information on emissions analysis for ramp metering refer to the Off-Model Air Quality Analysis: A Compendium of Practice, Federal Highway Administration Region Four, September 1997 included in the appendix of this report.

Traffic Control

Traffic signals that are interconnected and include traffic adaptive and responsive capabilities have proven to improve traffic progression and reduce delays. Additionally, the interconnection of signals working together has high environmental benefits in the reduction of fuel consumption and emissions. These benefits are illustrated by the examples below:

A Texas state program called the Traffic Light Synchronization (TLS) involved the installation of a system which tied each signal within the system together using communication interconnect with a modem link back to a shop computer. The system has resulted in benefits shown below with an estimated benefit/cost ratio of 62:1.[7]

TLS Summary:

Travel Time	13.8%	decrease
Travel Speed	22.2%	increase
Delay	37.1%	decrease
Fuel Consumption	5.5%	decrease
CO Emissions	12.6%	decrease
HC Emissions	9.8%	decrease

Another example that demonstrates the effectiveness of interconnected signals, is the city of Toronto's evaluation of the SCOOT signal control system. This system is comprised of 75 signals and is installed on two corridors and the central business district. The evaluation showed a decrease in both travel time and vehicle stops by 8% and 22%, respectively, and a reduction in delay by 17%. Moreover, due to the

[6]"Comparison of Conceptual System Design and Costs: ITS Surveillance and Communication Applications: Rural vs Urban Freeway Corridors," prepared by Edwards and Kelsy for the I-95 Corridor Coalition, September 1995.
[7] Benefits of the Texas Traffic Light Synchronization Grant Program I, TxDOT/TTI Report #0258-1, Texas DOT, Austin,

improved traffic flow, fuel consumption was reduced by 6%, carbon monoxide (CO) emissions by 5% and hydrocarbon (HC) emissions by 4%.[8]

For methodologies on analyzing emissions reduction, refer to the Off-Model Air Quality Analysis: A Compendium of Practice provided in the appendix of this report.

Emergency Vehicle Preemption

Emergency vehicle preemption works with traffic signal systems by alerting the signals of their oncoming presence up to a half-mile away. Traffic signals can then adjust their timing and allow emergency vehicles to proceed through an intersection with little delay. This system greatly reduces the chances of a collision at an intersection that in return saves costs in both emergency vehicle replacements and the legal liability when a motorist is injured. In addition, emergency vehicle preemption allows emergency vehicles to reach their destination faster which can make a difference between life and death in many emergency situations. This system works in concert with a well timed signal system to provide priority for emergency services while having minimal impact on other traffic.

Transit

Smart Card Technology

Smart Card Technology is a form of electronic payment that permits the same method of payment for all public transit systems. Through a computerized system, the smart card has the ability to track the fare accounts and demands of its riders as well as their respective travel patterns. Information obtained from the smart card system such as route, time or type of fare can be used to modify and/or expand transit routes based on user habits. In addition, this system improves the accuracy and reduces the costs for data collection when research is needed. The use of the Smart Card promotes traveler convenience that also encourages increased use of the public transit systems.   Smart Card technology is most effective when used in conjunction with AVL devices and bus arrival systems.

Refer to the Off-Model Air Quality Analysis: A Compendium of Practice provided in the appendix of this report for methodologies of calculating the effects of transit improvements on air pollution.

Transit Management System (AVL, etc.)

The implementation of a complete Transit Management System has shown to increase ridership and reduce costs for transit operators. For example, Winston-Salem, North Carolina evaluated a computer aided dispatch and scheduling system on a 17 bus fleet. Within six months the ridership grew from 1,000

[8] Glassco, R., "Potential Benefits of Advanced Traffic Management Systems," The MITRE Corporation, ITS-L-141, November, 1995.

to 2,000 users and vehicle miles per passenger-trip grew 5%. Moreover, operator expenses dropped 2% per passenger trip and there was a decrease in passenger wait time by 50%.[9]

Transit management systems also provide more efficiency for transit operations and may enable transit operators to streamline operations. Kansas City, Missouri was able to reduce 10% of the equipment required for some bus routes by using AVL/CAD while maintaining customer service. In addition, the use of an AVL system allowed Kansas City to eliminate seven buses out of a 200 bus fleet, thus allowing Kansas City to recover its investment in the AVL system within two years.[10]

Refer to the Off-Model Air Quality Analysis: A Compendium of Practice provided in the appendix of this report for methodologies of calculating the effects of transit improvements on air pollution.

Transit Priority

The transit priority allows for special treatment to transit vehicles at signalized intersections on roads with significant transit use. Three types of priority strategies exist. The first type of priority is the passive priority strategy that incorporates the timing of coordinated signals at the average bus speed instead of the average vehicle speed. The second type of priority is the active priority strategy that involves signals detecting the presence of a transit vehicle and thereby granting an early green signal or holding a green signal that is already displayed. The third priority strategy involves a short stretch of bus lane at the intersection called the queue jump lane. This enables buses to by-pass waiting queues of traffic and to cut out in front by receiving an early "bus only" green signal. By including at least one or all of the priority strategies, the average travel time per transit route can be reduced substantially.

The success of this type of program is demonstrated by two cities already employing priority strategies. Los Angeles has incorporated the signal priority on two routes called the Metro Rapid along the Whittier-Wilshire Boulevard and Ventura Boulevard. Total travel time for each Metro Rapid route has dropped by 25% compared to regular local service. Vancouver , Canada introduced the 99 B-line rapid bus along a 11mile cross town route with 14 stops. Travel times for this route were reduced by 20-40% compared to the local bus travel times. This program was successful enough to add a second rapid bus route in September of 2000.[11]

Refer to the Off-Model Air Quality Analysis: A Compendium of Practice provided in the appendix of this report for methodologies of calculating the effects of transit improvements on air pollution.

Traveler Information

Web/Roadway Traveler Information System

Providing traveler information over several modes of travel can be beneficial to both traveler and service providers. Several transit agencies as well as some Traffic Management Centers have started using kiosks, local cable television and web sites to disperse information about current traffic conditions and

[9] Stone, J., "Winston-Salem Mobility Management: An Example of APTS Benefits, "NC State University, 1995.
[10] Giugno, M., Milwaukee County Transit System, July 1995 Status Report.
[11] Bus Rapid Transit Web Site, brt.volpe.dot.gov/guide/signal.html, February 14, 2001.

transit schedules. This enables travelers to make more informed decisions for trip departures, routes and modes of travel. They have been shown to increase transit usage, and may help reduce congestion when travelers select alternate routes or postpone trips.

An example of how effective the traveler information system can be is illustrated by the surveys performed in the Seattle, Washington and the Boston, Massachusetts areas. These surveys indicated that when provided with traveler information, 30%-40% of travelers adjusted their travel. Of those that changed their travel, 45% of travelers changed their route of travel and 45% changed their time of travel, while the remaining 10% changed their mode of travel.

Traveling information systems are believed to greatly impact vehicle emissions as well. In 1999, it was projected that 96,000 callers would use the SmarTraveler system in Boston on a daily basis . To estimate the impact the SmarTraveler system would have on emissions, the MOBILE5a model was used but included only 30% of the projected 96,000 daily callers. The results from the model concluded that on a daily basis there would be an average reduction by 25% of volatile organic compounds, as well as 1.5% of NO_x and 33% of CO as compared to daily vehicle emissions not influenced by the SmarTraveler system[12].

Refer to the Off-Model Air Quality Analysis: A Compendium of Practice provided in the appendix of this report for methodologies of calculating the effects of transit improvements on air pollution.

Other ITS Benefits

Arterial Management Systems

Arterial Management systems are used to manage the traffic and control of arterial roadways through signal coordination, surveillance, sign control, and motorist informational systems. Traffic management centers also play an important role in these systems by monitoring and controlling traffic conditions and dispersing information to motorist about the arterial roadways. There have been numerous evaluations on the arterial management systems operating in cities around the world that have determined that these systems produce substantial environmental benefits by reducing vehicle stops, which then creates a reduction in fuel consumption and vehicle emissions. Additionally, arterial management systems have improved methods for reducing incident delays, increasing average speeds, as well as lowering accident rates. Arterial management systems are most effective when used in conjunction with incident management and transit management systems. Moreover, when multiple operational components are implemented such as surveillance, motorist informational systems as well signal coordination, a traffic management center has greater adaptive capabilities and control to improve changing traffic conditions.

A good example of how arterial management systems can substantially improve traffic conditions is demonstrated by a 1994 evaluation of a computerized signal control in the City of Los Angeles. This system had been in operation since 1984 and as of 1994 it was comprised of 1,170 intersections and 4509 detectors for signal timing optimization. The results of this evaluation reported a 13% decrease in

[12] Tech Environmental, Inc., Air Quality Benefit Study of the SmarTraveler Advanced Traveler Information Service, July 1993.

vehicle stops, 18% reduction in travel time, 16% in average speed, 13% decrease in fuel consumption and 14% decrease in emissions.[13]

There are many different types of ITS devices that produce successful arterial management systems. In Fairfax City, Virginia a program was started that used automated cameras to record violations and ticket violators in an effort to reduce intersection accidents. It was reported that after the program was implemented there was a 35% reduction of accidents at intersections with traffic lights. Arterial management systems can increase overall capacity of existing roadways, increase road safety for motorist and improve the environment at a justifiable cost.

Refer to the Off-Model Air Quality Analysis: A Compendium of Practice provided in the appendix of this report for methodologies of calculating the effects of signal improvements on air pollution.

Lane Control and Reversible Lanes

Lane Control utilizes various forms of dynamic message signs and specific lane control signs to convey directional, speed regulatory, warning and travel information to freeway users. There are several ways lane controls can be used. One example of lane control is when a reversible lane is used to convey high traffic volumes for each approach. The lane control signs, which are usually displayed well in advance of a merge, are used to close a lane on whichever approach has the lower volume during a given time period and keeps all lanes open for the higher volume approach. Additionally, lane control displays are used to convey messages of speed control for particular lanes due to accidents, weather conditions, construction or special events. Lane control is beneficial because it can decrease traffic congestion and reduce vehicle delays. Moreover, with a reduction in idling vehicles, lane control will also help to reduce air polluting vehicle emissions. Another Lane control benefit is the reduction in vehicular accidents. In England, a system incorporating lane control paid for itself within a year based solely on accident reductions[14].

National Architecture Compliance

The development of the short- and long-term projects is the final step before the development of the regional architecture. The regional architecture that is used is a derivative of the national architecture as previously discussed. However, the regional architecture includes multiple figures and tables that document the relationships between various components, control centers, and agencies. The regional architecture documentation and all associated figures are provided as a supplement to this report.

The intent of the regional architecture is to document the flows of data between the many elements that are currently and will ultimately be deployed throughout the Wilmington Region. Based on the regional architecture, as individual projects are developed, they can be incorporated to ensure that information is shared throughout the region.

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[13] City of Los Angeles Department of Transportation, "Automated Traffic Surveillance and Control (ATSAC) Evaluation Study," June 1994.
[14] Freeway Lane Control, www.bts.gov/ntl/99030/s03/body_s03.html, accessed 2/28/01

The architecture database that has been prepared for this report is not intended to sit on a shelf. Rather, it is intended to be a living database that is updated as projects are deployed or new projects are planned.

Standards

In additional to compliance with the National Architecture, USDOT has been working with the industry to develop standards for use within the ITS community. The most common standard that has been deployed to date is the National Transportation Communication for ITS Protocol (NTCIP) for traffic signals. As of 1999, NTCIP was the only widely adopted standard. However, there are many more that are being developed and approved nationally for use in ITS. The standards that have been identified are:

Relevant Standards Activities

Organization	Standard Name	Standard Number
AASHTO	NTCIP - Application Profile for File Transfer Protocol (FTP)	2303
AASHTO	NTCIP - Application Profile for Trivial File Transfer Protocol	2302
AASHTO	NTCIP - Applications Profile for Data Exchange ASN.1 (DATEX)	2304
AASHTO	NTCIP - Base Standard: Octet Encoding Rules (OER)	1102
AASHTO	NTCIP - Subnetwork Profile for Ethernet	2104
AASHTO	NTCIP - Subnetwork Profile for Point-to-Point Protocol using RS 232	2103
AASHTO	NTCIP Guide	9001
AASHTO	NTCIP - Object Definitions for Video Switches	1208
AASHTO	NTCIP - Simple Transportation Management Protocol (STMP)	1103
AASHTO	NTCIP - Profiles - Framework and Classification of Profiles	8003
AASHTO	NTCIP - Data Dictionary for Closed Circuit Television (CCTV)	1205
AASHTO	NTCIP - Applications Profile for Common Object Request Broker Architecture (CORBA)	2305
ASTM	Standard Specification for DSRC - Physical Layer 902-928 MHz	PS 111-98
ASTM	Standard Specification for DSRC - Data Link Layer	Draft Z7633Z
EIA/CEA	Data Radio Channel (DARC) System	EIA-794
EIA/CEA	Subcarrier Traffic Information Channel (STIC) System	EIA-795
ANSI	Commercial Vehicle Safety Reports	TS284
ANSI	Commercial Vehicle Safety and Credentials Information Exchange	TS285
ANSI	Commercial Vehicle Credentials	TS286
IEEE	Standard for Common Incident Management Message Sets (IMMS) for use by EMSs	P1512
ITE	Advanced Traffic Controller (ATC) Application Program Interface (API)	9603-1
ITE	ATC Cabinet	9603-2
ITE	Advanced Transportation Controller (ATC)	9603-3
ITE	Message Set for External TMC Communication (MS/ETMCC)	TM 2.01
ITE	Standard for Functional Level Traffic Management Data Dictionary (TMDD)	TM 1.03
IEEE	Survey of Communications Technologies	ITSPP#5
IEEE	ITS Data Dictionaries Guidelines	ITSPP#6A
AASHTO	NTCIP - Simple Transportation Management Framework (STMF)	1101
AASHTO	NTCIP - Class B Profile	2001

AASHTO	NTCIP - Global Object Definitions	1201
AASHTO	NTCIP - Object Definitions for Actuated Traffic Signal Controller Units	1202
AASHTO	NTCIP - Object Definitions for DMS	1203
AASHTO	NTCIP - Point to Multi-Point Protocol Using RS-232 Subnetwork Profile	2101
IEEE	Guide for Microwave Communications System Development	1404
IEEE	Recommended Practice for the Selection and Installation of Fiber Optic Cable	P1454
IEEE	Message Sets for DSRC ETTM & CVO	1455
IEEE	Standard for Message Set Template for ITS	P1488
IEEE	Standard for Data Dictionaries for ITS	1489
AASHTO	NTCIP - Transportation System Sensor Objects	1209
AASHTO	NTCIP - Data Collection & Monitoring Devices	1206
AASHTO	NTCIP - Application Profile for Simple Transportation Management Framework (STMF)	2301
AASHTO	NTCIP - Internet (TCP/IP and UDP/IP) Transport Profile	2202
SAE	Truth-in-Labeling Standard for Navigation Map Databases	J1663
SAE	Serial Data Comm. Between MicroComputer Systems in Heavy-Duty Vehicle Applications	J1708
SAE	Information Report on ITS Terms and Definitions	J1761
SAE	A Conceptual ITS Architecture: An ATIS Perspective	J1763
SAE	ISP-Vehicle Location Referencing Message Profiles	J1746
SAE	On-Board Land Vehicle Mayday Reporting Interface	J2313
SAE	Information System (ATIS) Data Dictionary	J2353
SAE	Advanced Traveler Information System (ATIS) Message Set	J2354
SAE	ITS Data Bus Architecture Reference Model Information Report	J2355
SAE	Standard for Navigation and Route Guidance Function Accessibility While Driving	J2364
SAE	ITS Data Bus Protocol - Link Layer Recommended Practice	J2366-2
SAE	ITS Data Bus Gateway Recommended Practice	J2367
SAE	ITS Data Bus Conformance Test Procedure	J2368
SAE	Standard for ATIS Message Sets Delivered Over Bandwidth Restricted Media	J2369
SAE	Field Test Analysis Information Report	J2372
SAE	Stakeholders Workshop Information Report	J2373
SAE	National Location Referencing Information Report	J2374
SAE	ITS In-Vehicle Message Priority	J2395
SAE	Measurement of Driver Visual Behavior Using Video Based Methods (Def. & Meas.)	J2396
SAE	Adaptive Cruise Control: Operating Characteristics and User Interface	J2399
SAE	Forward Collision Warning: Operating Characteristics and User Interface	J2400
SAE	ITS Data Bus Data Security Services Recommended Practice	J1760
SAE	ITS Data Bus Protocol - Physical Layer Recommended Practice	J2366-1
SAE	ITS Data Bus Protocol - Thin Transport Layer Recommended Practice	J2366-4
SAE	ITS Data Bus Protocol - Application Layer Recommended Practice	J2366-7
ITE	TCIP - Control Center (CC) Business Area Standard	1407
ITE	TCIP - Common Public Transportation (CPT) Business Area Standard	1401
ITE	TCIP - Fare Collection (FC) Business Area Standard	1408
ITE	TCIP - Framework Document	1400

ITE	TCIP - Incident Management (IM) Business Area Standard	1402
ITE	TCIP - Onboard (OB) Business Area Standard	1406
ITE	TCIP - Passenger Information (PI) Business Area Standard	1403
ITE	TCIP - Scheduling/Runcutting (SCH) Business Area Standard	1404
ITE	TCIP - Spatial Representation (SP) Business Area Standard	1405
ITE	TCIP - Traffic Management (TM) Business Area Standard	TS 3.TM

The first priority with the continued deployment in the Wilmington region is to comply with national standards. However, a number of choices were made in the development and deployment of ITS technologies over the past few years that will impact the standards that are chosen. An example is emergency vehicle preemption. To date, all of the deployments for emergency vehicle preemption have used 3M Opticom® equipment. This system uses a proprietary interface that is not standard. To change this to an open standard driven system, would require that all of the existing Opticom® equipment be either replaced or upgraded (if possible). This is not feasible. In instances such as this, the existing system will be maintained.

Regional Communication Architecture

Based on the short- and long-term projects, the key component of the Wilmington Region ITS Deployment plan is to develop a central database of traveler information to be disseminated to motorists throughout the region. This regional system, with the various inputs and outputs is shown in **Figure 12**

The concept of this architecture is that the City of Wilmington controls a majority of the traffic operations equipment through the region, and, therefore, has easy access to a majority of the traffic information generated by these elements. External inputs, such as the IMAP program and the NCDOT statewide program office needs to be accessed, but not generated or stored locally.

The concept of the architecture is that the City of Wilmington and NCDOT share information both regionally and, to some extent, statewide to provide information that can be easily accessed from one concise front end. There are two options to operate a regional traveler information system: central and virtual. These two concepts are shown in **Figure 13**.

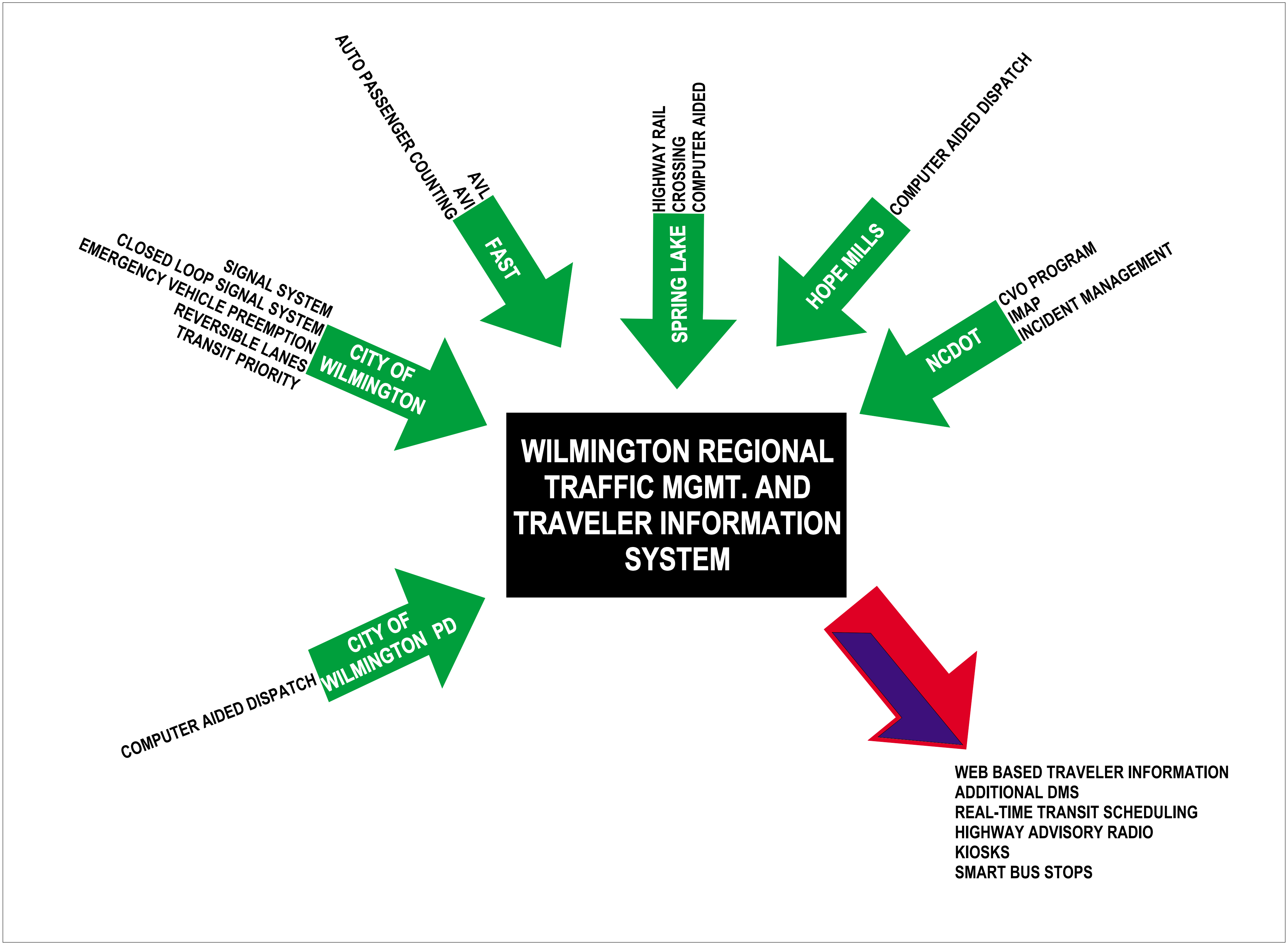


FIGURE 12 GENERIC REGIONAL ARCHITECTURE

Kimley-Horn
and Associates, Inc.

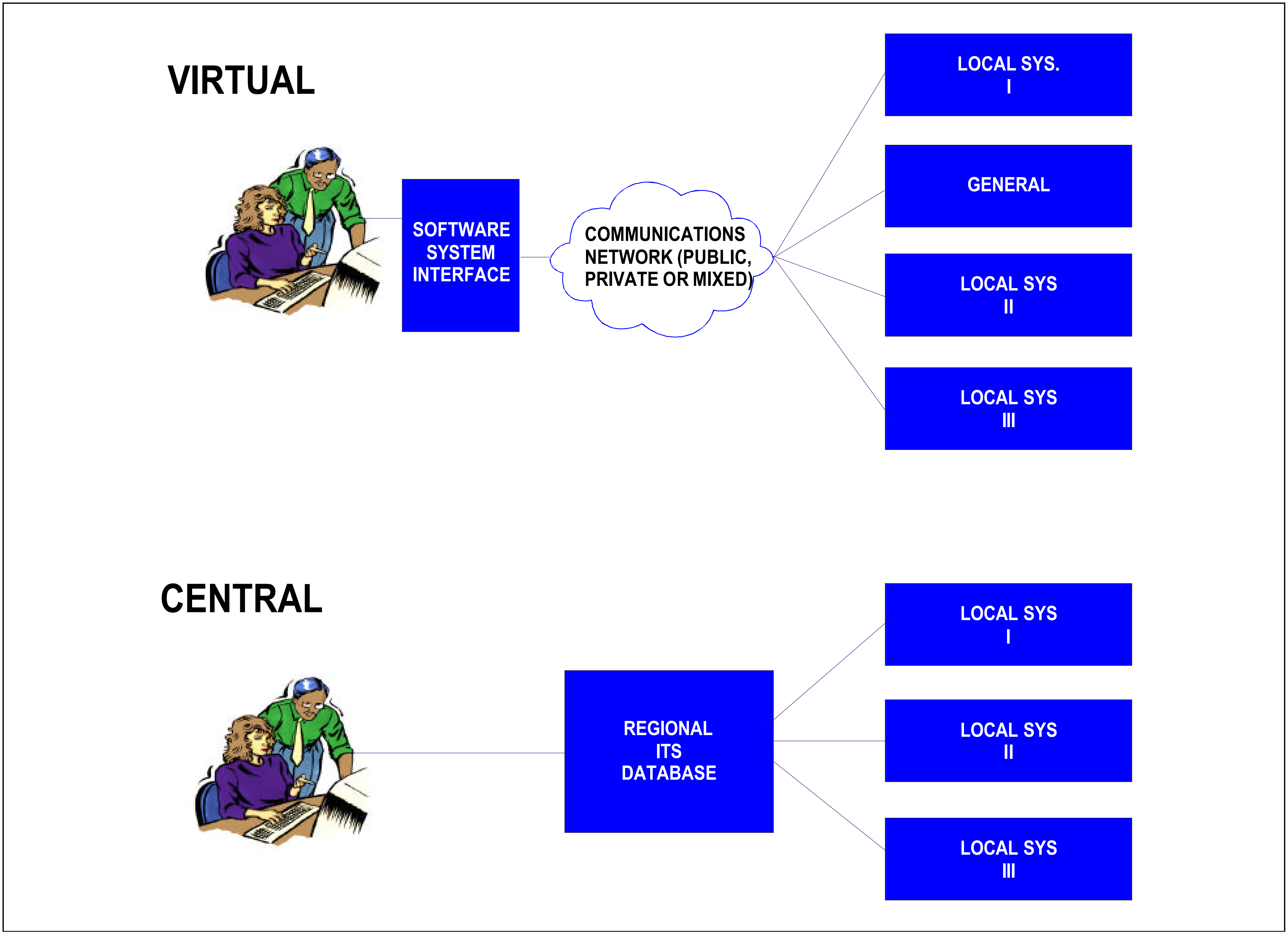


Figure 13 Central vs. Virtual Information System

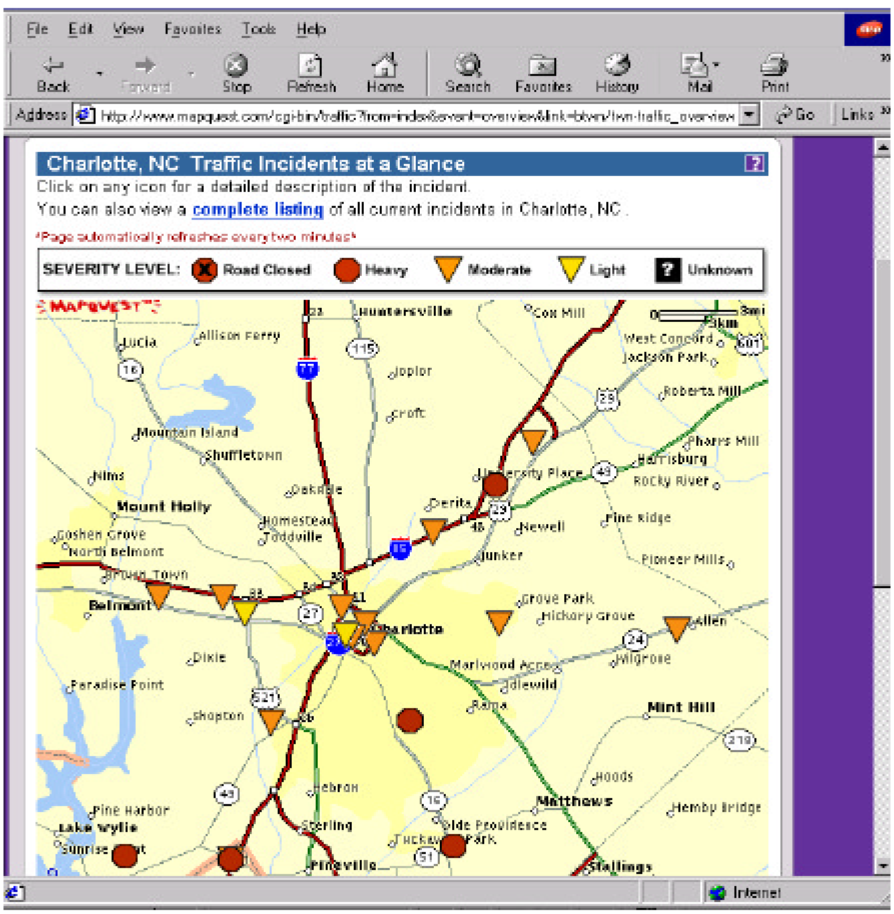
Kimley-Horn and Associates, Inc.

Central Information System

A central system is the more expensive of the two to design, build, operate, and maintain. A central system requires that all the data, video, and other information be brought to one central location for dissemination. For instance, the NCDOT could house the information system. This system would store all of the information, both data and video, and disseminate it as needed. A type of central system is provided by MapQuest at www.mapquest.com. MapQuest's traveler information pages get data from the DOT and provide it on the MapQuest. A sample image from MapQuest is provided for the Charlotte areas in **Figure 14**.[15]

Mapquest is a sample of a third party using available information to document and present traffic conditions in real time. Other web sites with similar information include www.smartroutes.com, www.strategy.com (under development), and others.

Figure 14. Sample MapQuest Image.



The advantage of a central system is that is provides consistency to the end user in both the look and feel, but also in the data and video provided. A central system provides greater control over the

[15] MapQuest is just one of many private sector companies repackaging ITS information for profit. Others include Yahoo! (traffic.yahoo.com),SmartRoutes (www.smartroutes.com) and TrafficStation (www.trafficstation.com).

information, in that one agency, organization, or even person has the ultimate responsibility for all of the system's components.

The key disadvantage is the cost needed to design, construct, operate and maintain such a system. Where a virtual system would require that the end user have an adequate connection to the regional and local sites, the central system requires that there be a permanent connection from the central system to each of the local sites. In essence, the responsibility of data and video dissemination falls on whoever is operating the central system.

Virtual Information System

A virtual information system requires less front-end expense than the central system, but also has issues with compatibility and consistency. A virtual system provides a front-end for the user from which he or she can select the information that is desired. When selected, however, the user connects directly to the local system from which information is requested. The only information stored at the central location is the front-end and generic regional information. All of the specific data and video can be accessed from each of the local sites.

The advantage of a virtual system is that it provides all of the same information as a central system, but at a lower front cost. The requirements for the virtual system are solely a link from the central system to each of the local systems. The bandwidth for the local systems to transmit this information to the end user is the responsibility of the local agencies. A virtual system is very similar to the World Wide Web. A site like www.yahoo.com provides traffic and traveler information through links to the various sites. This is similar to a virtual system.

The key disadvantage of the virtual system is the consistency amongst the sites, both in terms of look and feel, as well as status. Different internet sites have different methods of presenting information. Unlike a central system where one person or group has control of the look of a site, a virtual system has different groups of people responsible for each of the local sites, which can confuse users. This problem can be eliminated by standardizing the front ends of the various systems.

It is important that the status of the varying sites be consistent. Where the central system has all of the data and information stored and processed locally, the virtual system relies on other sites to be operational, up to date, and consistent. If it is not, users will stop visiting the site for traffic and traveler information.

Regional Architecture Recommendation

The Wilmington regional plan focuses on improving the existing ITS deployments and enhancing traveler information. This deployment has promoted the deployment of a centralized communication system. Although there will be a number of virtual elements, specifically regarding information from NCDOT both regionally and statewide, the vast majority of input into the system are currently centralized, and should remain that way.

Communication System

The regional communication is limited because of the deployments, both existing and planned, and the geography of the region. The system will encompass the existing communications between Wilmington and the existing ITS elements, with new deployments providing or improving communication as necessary. The regional communication topology is shown in **Figure 15**.

Additional infrastructure desired for this project will be developed as part of the short- and long-term projects. Each project that requires communications should be deployed with the intent of expansion of communications, since the addition of fiber for the regional system adds an insignificant cost (The vast majority of installing fiber optic cable is in the trench, conduit and labor to install the cable. Installing additional strands do not add a significant amount per linear foot of cable).

Communications Assessment

The only regional communications that are required for the short- and long-term ITS deployment in the Wilmington region is the communications necessary to connect Wilmington to the NCDOT statewide system. A full-time connection is recommended between Wilmington and NCDOT to share video and data. The statewide standard that is being recommended from each region is a 3 Mbps (2 T-1 Lines) connection. This will permit, as described below, multiple low frame rate video channels to be transmitted across the network until a statewide network is fully developed. The communications plan is shown in **Figure 16**.

The statewide link is necessary for a number of reasons, most notably to view traffic in the Triangle, Triad and Metrolina regions, and for those regions to view traffic in the Wilmington region. Additionally, traffic in Wilmington can significantly impact the I-40 and I-95 corridor as well as the opposite. Traffic monitoring and control is a local issue, with regional and statewide impacts. For that reason, transmitting basic data and video images to a statewide network does not require the same quality as for local information. Video images from Wilmington to NCDOT are recommended to be limited to 384 Kbs.

The statewide link is recommended to be a leased network at this time. There are many states in the process of developing statewide fiber optic deployments from border to border along the major freeways with assistance from private partners. In lieu of this occurring in North Carolina, a statewide leased network is sufficient to provide basic data and video transmission. It is recommended that a total of 2 T-1 connections be provided from the Wilmington region to NCDOT headquarters in Raleigh. The cost to lease the bandwidth required to connect these two centers would be approximately $30,000 per year, in addition to a one-time setup and installation cost of approximately $20,000.

Video images can be broadcast or transmitted at different data rates, depending on the quality desired by the viewer. The higher the data rate, the better the quality. As data rates decrease, images tend to become either smaller or jumpy. It is recommended that for center to center video, a data rate of between 3 and 6 Mbs (Megabits per second) be used. This rate will allow full frame, full motion video with little or no “jumping.”

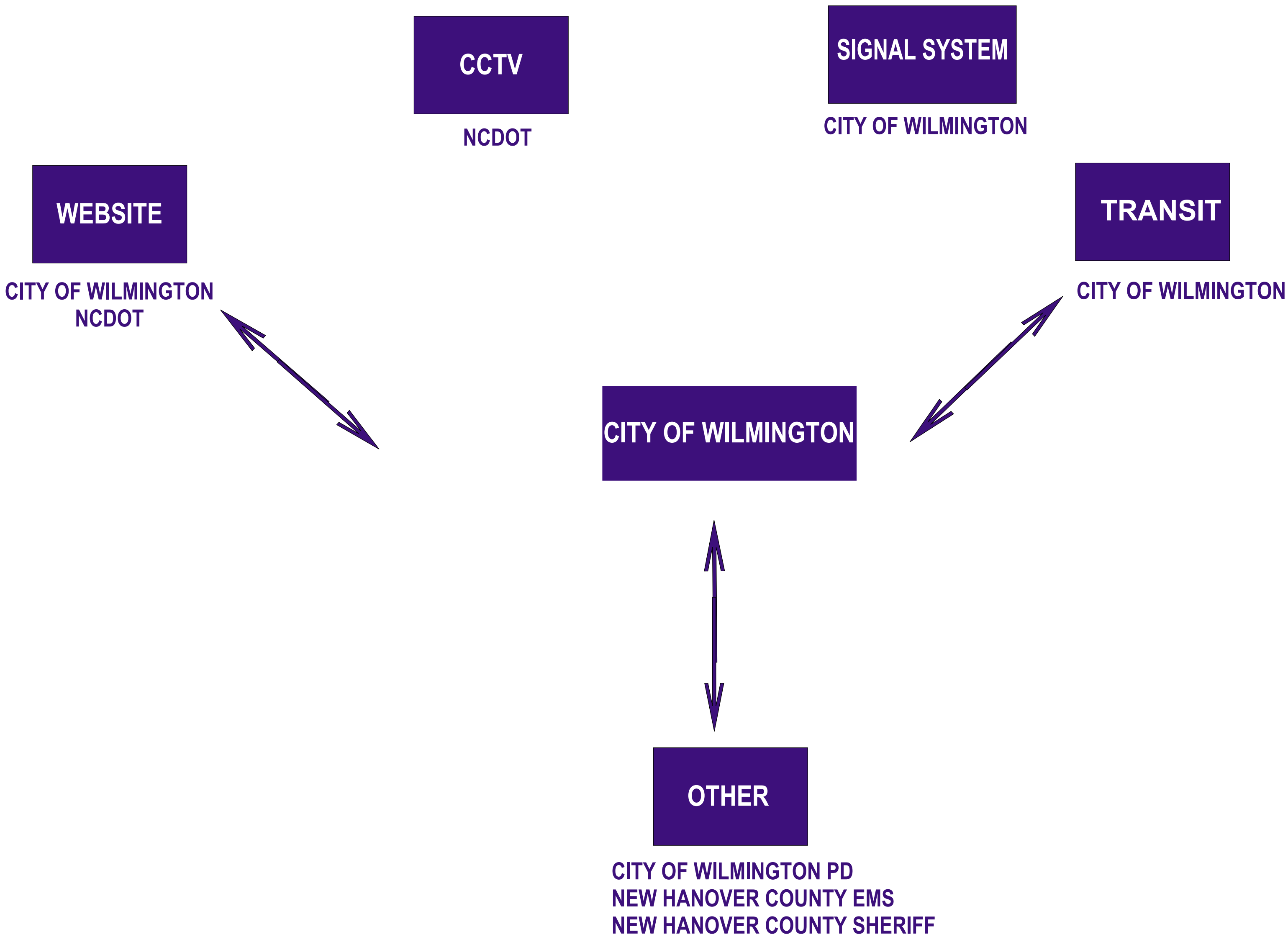


FIGURE 15 PROPOSED COMMUNICATION TOPOLOGY

Kimley-Horn and Associates, Inc.

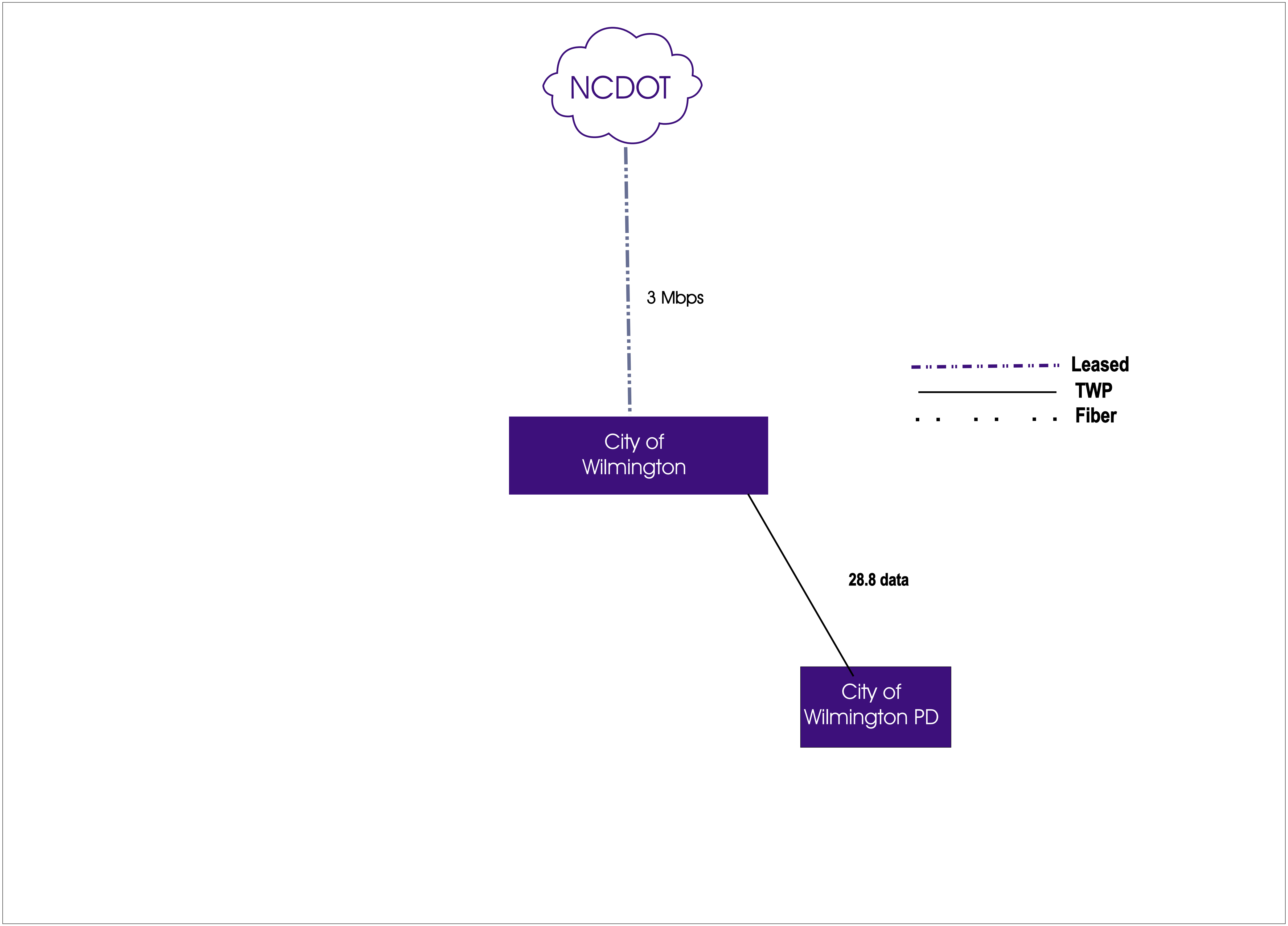


FIGURE 16 WILMINGTON REGION COMMUNICATION PLAN

Kimley-Horn
and Associates, Inc.

Video between Wilmington and the rest of the state can vary depending on the bandwidth available, and expand as the communication infrastructure increases. For the purposes of traffic control video, a low data rate of 1.5 Mbs is reasonable, since it can be transmitted over one leased T-1 line. The video transceivers and multiplexers available today allow the data rate to be changed, so as different communication options become available, the only changes necessary in the end equipment is in the software to convert the data rate, and in the network interface to change connection types.

Data transmission of traffic information is significantly reduced from the needs of video transmission. Typical data from a traffic signal system is constant, but not at a high data rate (most controllers are limited to data rates as low as 14.4 or 28.8 Kbs. Data from other sources, such as traffic data count stations, DMS and HAR does not require continuous communications, rather the data (or voice for HAR) is sent in a burst. The more bandwidth available, the shorter the burst.

Communications between the City of Wilmington and surrounding communities is recommended to continue using standard telephone service. Although the information collected by the various elements encompassing the ITS deployment in the Wilmington Region can impact these other municipalities, a majority of the impacts and response will be handled by the City of Wilmington. The bandwidth necessary to transmit basic data between Wilmington and these surrounding communities will be very limited. A majority of the incident responses that require multiple jurisdictions will be coordinated by the City of Wilmington or the police departments. Communications during these events will occur via either radio or telephone. A standard telephone line connecting these facilities will permit the exchange of basic data and still frame video images.

APPENDIX

Meetings

Summits

NIA Compliance

FHWA: Off-Model Air Quality Analysis – A Compendium of Practice – August 1999